Engineering News

Vol. 68. No. 6 505 Pearl Street, New York August 8, 1912

Flood on the Wisconsin River at and near Wausau, Wis.

An exceedingly heavy rainfall over a limited area occurred in the Wisconsin River Valley at and about Wausau, Wis., on July 23, 1912, and caused a very high and sudden flood in that river and its tributaries, with resulting heavy property loss. So far as can be learned, no lives were lost. We have received both from W. E. Miller, Civil Engineer Inspector, R. R. Commission of Wisconsin, Madison, Wis., and from D. S. Burnett, a civil engineer of Wausau, accounts and photographs of the flood and the damage done by it. From these two accounts we have prepared the following article.

It began raining about 4 a.m., July 23, and continued with extreme violence for nearly 24 hours. In the words of one of our correspondents, "it rained a regular old-fashioned sod soaker, or in this case, a gully washer, until about midnight of July 23. There was scarcely an intermission between downpours. At about 6 p.m. an electric storm, cyclonic in its action, came up from the southwest and an extremely heavy fall of rain followed, and increased to the extent of what is known as a cloudburst." The heavy rain was confined to the Wisconsin River drainage area over a circle some 50 miles in diameter, with the town of Merrill, some 16 miles north of Wausau, on the river, as a center. At Merrill the official rain gage registered 11¼ in. from Monday night, July 22, to 11 p.m., July 23, during which time the rain lasted about 19 hours. At Wausau the total fall was somewhat less.

There are numerous water powers on the upper Wisconsin River, many of which have been developed. The interest of their owners in the regulation of the flow of the river and in the prevention of low water as far as practicable led to the organization, some years ago, of the Wisconsin Valley Improvement Co. This company has done a great amount of work in developing storage reservoirs and regulating works among the numerous lakes at the headquarters of the river. It maintains rainfall- and river-gaging stations and gate tenders, and has largely increased the dry-season flow above what it otherwise would be. So far as we can discover there were no reservoirs of any size in the limited area covered by this rainfall, most of them being north of the line of heavy rain. The river drains a valley of about 40 miles width at this location, with several streams tributary to it, the main ones being the Prairie, Tomahawk, Big Pine, Little Pine, Trapp, Big Rib and Eau Claire. On the main river between Merrill, 22 miles above Wausau, and Rothchild, 4 miles below Wausau and on the Eau Claire River, emptying into the Wisconsin just below Wausau, the greatest damage was done. On account of the larger number of bridges and dams at Wausau proper, the maximum loss fell on the property there. The total losses will equal over $1,000,000.

The topography of that portion of the state in which the cloudburst occurred is such as to make the run-off quite rapid, hence the Wisconsin River and some of its eastern tributaries rose very rapidly. The following table presents the readings taken on the U. S. river gage located at Wausau, just above the McEachron mill at the main dam (Fig. 1).

Date		Hour	Gage
July	22	7:30 a.m.	3.6 ft.
"	22	5:30 p.m.	3.4
"	23	7:30 a.m.	3.6
"	23	5:30 p.m.	3.3
"	24	8:00 a.m.	15.3
"	25	7:30 a.m.	16.3
"	25	5:30 p.m.	9.0
"	26	7:30 a.m.	8.0
"	26	5:30 p.m.	7.5

The accompanying Fig. 1 shows the general course of the river at Wausau, and is marked with letters (A to F) to indicate the location of the photographs reproduced in this article. The damage along the river was mainly to dams and bridges, and may be itemized as noted below:

THE DAM AT ROTHCHILD, WIS. LEFT-HAND PART SWEPT AWAY BY FLOOD

INJURY TO DAMS

Injuries to dams along the line of flood are reported at the following towns:

MERRILL (22 miles above Wausau)—Grandfather Falls Co. dam on Prairie River at Merrill. Concrete Construction with earth wings. Wings reported to have given away at 4 a.m., July 24. Water about 15 ft. above normal.

Lindauer's dam on Wisconsin River, at Merrill. Rock-filled timber-crib dam. River cut through about 3:30 a.m., July 24.

BROKAW (6 miles above Wausau)—Timber-crib construction, rock-filled, on rock ledge. The original structure was built for a flood dam for log-driving purposes many years ago, and in 1908 and in 1909 the dam was strengthened by putting in some new timbers and raising it

to hold a head of 18 ft. It originally held about 12 ft. head. Each succeeding year a little more head has been held by putting on flashboards and adding to their gates until about 20.5 ft. has been held. The dam was a very faulty structure and being thus heavily overloaded gave way when the extra strain of the flood hit it. This is an ideal place for a dam, having rock bottom and one rock shore to anchor to, without which it would have long since gone out.

The loss to the company, The Brokaw Paper Mill Co., is estimated at about $80,000, although if a substantial dam is built here it will involve a cost of three times that amount. This company lost about four million hemlock logs which are scattered over 50 miles of river.

WAUSAW—The Wausau Electric Power Co. dam, shown in Fig. 3, suffered the greatest damage in Wausau. About 125 ft. of dam was washed away, and the electric power for the city shut off. This dam was of concrete except a portion on the right hand of the view which was masonry, the masonry and concrete being built in front of an old crib dam. The breakage occurred at the juncture of the concrete and stone work. Logs and flood trash were piled 10 ft. high on top of this wall or dam before it finally gave way. There were no sluice gates or openings to allow any material to pass through, and being in a sort of a pocket there was absolutely no relief to be had. The flow through the break washed much of the fill and spoil bank into the tail race, which was filled with the débris. The damage to this plant and dam is estimated at about $75,000.

Water flowed into the generator room of the electric plant and reached a height of over 3½ ft., which was the height of the center of the shaft of the big generators. The plant has a steam turbine-driven generator of 750-kw. capacity, set well above the generator-room floor, and this was put into service on July 26, when the street-railway load was again taken on. Street-railway service had been suspended all of July 24 and 25. Commercial-lighting service was furnished as usual on the evening of July 24, the power being brought from the hydro-electric plant at Mosinee, on the Wisconsin River several miles below Wausau, by lines over which power was usually transmitted in the opposite direction. The Wausau Electric Co. water power will not likely be again put in service in less than three months.

A retaining wall at the plant of the Northern Milling Co., at location F, Fig. 1, was toppled over and the waterwheels in the plant badly damaged. Some machinery and also some material stored in the building were lost.

The main dam at Wausau did not break. This is a rock-filled, timber-crib dam 6 ft. high and 200 ft. long, at the head of Big Bull Falls, on the west side and near the north end of a granite island about 2000 ft. long (Fig. 1).

ROTHCHILD (four miles below Wausau)—The dam at this place was washed out in a flood of October, 1911, and was under course of construction when this flood took out the new work as shown on the left hand of the view on p. 233. Here bedrock is 42 ft. below the normal water level and steel sheet-piling was driven to that depth and a concrete dam was being built there. On the west bank (left-hand side of view) is a loose sand and gravel bank some 40 ft. high into which the dam was set about 40 ft. This

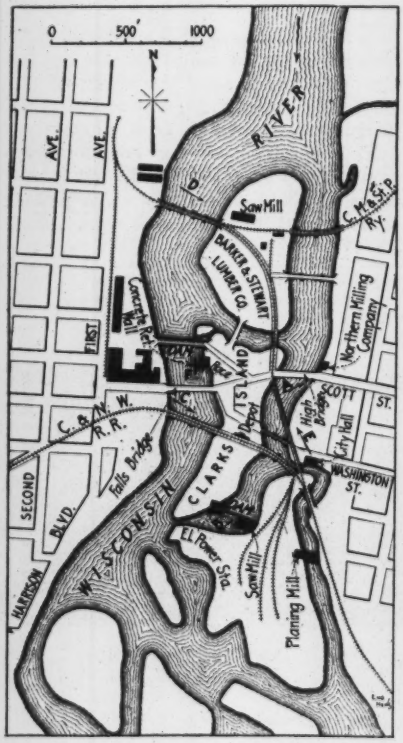


FIG. 1. MAP OF WISCONSIN RIVER AT WAUSAU, WIS.

bank, together with the coffer-dam, new concrete work, etc., was washed away by the flood of July 24. A gap of about 300 ft. is left to be filled by new construction. Damage from $50,000 to $100,000.

EAU CLAIRE RIVER—A dam at the village of Schofield, on the Eau Claire River, ½ mile above its confluence with the Wisconsin River, which is about two miles below Wausau, was destroyed. This was a timber dam about 350 ft. long with an 8-ft. head behind it. It is reported that a wing was washed away and the pond overflowed through the village.

Another timber dam (Kelly Dam) on the Eau Claire River, about two miles south and five miles east of Wausau, was washed away. This was the oldest dam in northern Wisconsin, having been built about 50 years ago. It was built of timbers of white pine, hewed and pinned together with wooden drift pins of the same material, and filled with stone. The break occurred when the water reached such a height that it cut around the bulkhead which protected the east bank. Such a stage of water was never known by the oldest residents on this stream before. It normally held about 10 ft. of water. A similar dam, known as the Callon Dam, situated about nine miles above the mouth of the Eau Claire River, also went out. It was of the same general design as the Kelly Dam.

DAMAGE TO BRIDGES

Throughout the whole area of the flood there was serious damage to bridges, but at Wausau, on account of the restricted waterway, the damage was greatest, particularly as the bridges there were larger than elsewhere. The map in Fig. 1 and the views of the bridges will show the extent of this damage.

Fig. 5 is the view of two of the three spans of the C. & N. W. Ry. and C., M. & St. P. Ry. bridge carrying an industry track over the west channel. The center span was carried down stream and sunk out of sight. The view is taken from the west and upstream side of the bridge (see Fig. 1). The destruction of this bridge may have been due to a log jam forming against it. The island at the east end of this bridge was occupied wholly by the Barker & Stuart Lumber Co., which had a large amount of lumber in logs in the river, and which also had the island practically covered with piles of sawed lumber. This piled lumber shows that the island was from 5 to 6 ft. under water. Many lumber piles were shifted and some floated away entirely. It was reported that this company had 15 million feet of lumber in logs get away and go down the river.

Fig. 2 is the wreck of the east end of High Bridge (see Fig. 1). The break in the abutment here was about 50 ft. wide. Fig. 4 shows the tail-end of the flood passing under the main-line bridge of the C. & N. W. Ry. It will be noted that the force was severe enough to tear out some of the stones in the middle pier, but not strong enough to wreck the bridge.

The entire pile-trestle city bridge at Bridge St. was carried away, as were a number of smaller foot bridges and railroad trestles. Three spans of a four-span steel highway bridge over the west channel in the southern part of Wausau were carried over ½ mile downstream on a log jam and lodged on a sand bar.

OTHER DAMAGE

The B. Heineman Lumber Co., located about ½ mile below the other lumber company, noted above, apparently lost heavily in sawed lumber, as there was but little of such lumber left in their

FIG. 2. WRECK OF WEST END OF HIGH BRIDGE, WAUSAU

(Location A, Fig. 1. The area covered with water is a part of the railway switch yards. The water at its highest stage stood 3 ft. above the guard locks shown.)

yard, while an area amounting to several acres just above Strollers' Bridge, farther downstream, was covered with a confused mass of logs, boards and timbers, sawmill refuse, barrels, boxes, bridges, and unbroken stacks of sawed lumber from 2 to 6 ft. in depth.

The water-works pumping station at Wausau is in the northern part of the city, on the east bank of the river. At 1:15 a.m., July 24, the station attendants were driven out by the flood. Water rose to a height of about 3½ ft. in the pump room and the old boiler room (now vacant), and to a height of 5 ft. in the new boiler house. At 3 a.m., July 25, the water stood about 3 in. over the new boiler-house floor, and at 6 p.m. about 30 in. below it. The fires had been started about 2 a.m., hence the plant was out of commission for about 25 hours. Very little damage was apparent about the pumping station. The water supply is pumped direct from two gangs of tubular wells, the older one consisting of thirty 6-in. wells and the new (1910) group of ten 10-in. wells, all about 130 ft. deep, sunk in gravel and sand.

The Wisconsin Valley division of the Chicago, Milwaukee & St. Paul Ry. suffered heavily for several miles. Traffic on this line north of Junction City was suspended from Tuesday night, July 23, until Friday morning, July 26, at which time a northbound passenger train got within a few miles of Wausau and transferred its passengers to another train for Wausau, half a mile farther north, the passengers walking that distance. A southbound train ran from Wausau at 8 p.m., July 26, transferring its passengers at the same place, in the same way.

It may be noted that this flood was in the county next east to the one in which extensive floods caused damage to the Dells and Hatfield Dams, on Oct. 6, 1911, as described by Prof. W. D. Pence in ENGINEERING NEWS, Oct. 19, 1911, p. 482.

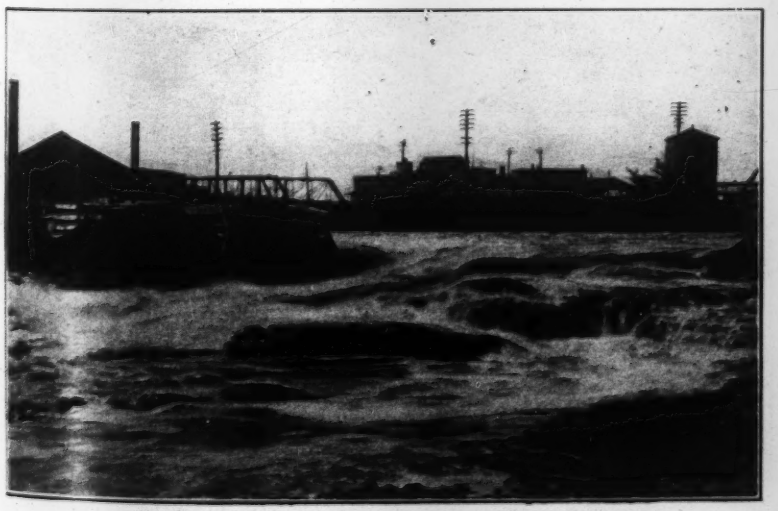


FIG. 3. WRECK OF DAM AT THE ELECTRIC POWER STATION, WAUSAU

(Location B, Fig. 1. About 125 ft. of dam washed away.)

Tests of a Blast-Furnace Type of Gas Producer*

In the producer-gas investigations of the U. S. Bureau of Mines much work has been done looking to the adaptability of the gas producer to the utilization of low-grade or high-ash fuels. The use of fuels of this type is far from general, although in many parts of the United States there are large quantities of such fuels which it would be of distinct advantage to utilize.

Laboratory experiments have shown† that the production of high percentages of CO in the producer gas is helped by having the fuel bed at a temperature of 2200° F. or over and that, at these temperatures, the capacity of a producer would be greatly increased. In usual practice, however, great care is taken to prevent the occurrence of such high temperatures in order to avoid fusing the ash and producing troublesome clinkers. Thus while high temperatures are theoretically desirable on one hand, practically they are undesirable on the other. The result of these conflicting conditions on the design and operation of gas-producer plants is a compromise; the temperatures are maintained as high as the character of the ash permits without the formation of objectionable clinker.

To obtain the advantages of high temperatures and to eliminate clinker troubles, suggestions have been made for a producer of the blast-furnace type in which the ash can be removed as a liquid slag. The first slagging producer recorded was that of Ebelmen in 1840, only a year after Bischof built the first internally-fired producer. In 1881, W. J. Taylor operated a slagging producer at Chester, N. J., and satisfactory results were reported. Until recently, this type seems to have dropped out of sight. A recent application of the idea in producer design is found in the "S. F. H." producer in France. A battery of these producers, installed in glass-works at Gironcourt-on-Vosges, in 1907, furnishes

*Arranged from Technical Paper No. 20, U. S. Bureau of Mines.

†Bulletin No. 7, U. S. Bureau of Mines, "Essential Factors in the Formation of Producer Gas," by J. K. Clement, L. H. Adams and C. N. Haskins.

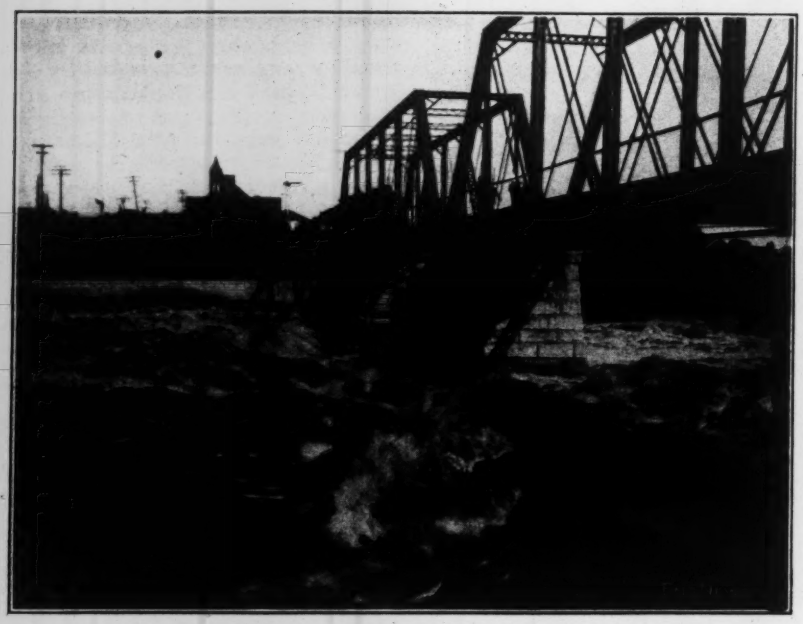


FIG. 4. FLOOD DAMAGE AT C. & N. W. R.R. BRIDGE, WAUSAU
(Location C, Fig. 1. Note stones torn out of middle pier.)

gas for several large plate and annealing ovens. An analysis of the fuel used is given as follows:

	Per cent.
Moisture	15
Volatile matter	25
Fixed carbon	35-40
Ash	20-25

An analysis of the gas is reported thus:

	Per cent.
CO_2 and SO_2	2-3
CO	28-30
H_2 and CH_4	9-10

The equipment installed at the station of the U. S. Bureau of Mines for the preliminary tests on this type included a producer, scrubber, gas meter, blower, preheater, steam boiler, and such scales, thermometers, thermocouples, and gas-sampling devices as were necessary.

The producer consisted of a cylindrical steel shell lined with brick and provided with a slag notch, through which the liquid slag was tapped off. Near the base of the producer were six air tuyeres, and, in addition to these, at points above, four separate tuyeres through which steam could be admitted. Fuel was charged at the top and gas was drawn off through the side near the top.

Because of the extreme temperatures in the combustion zone, a special cooling pipe coil was embedded in the brick lining. Between the coil and the fire was a 4½-in. layer of magnesite brick.

The scrubber consisted of a cylindrical shell containing numerous water sprays, but no baffle plates or coke layers. Gas entered at the bottom through a water seal and passed upward through the spray and finally through a layer of excelsior, acting as a dry scrubber.

The quantity of air was controlled by a regulating valve through which a part of the blast was bypassed to the atmosphere. The pressure was varied according to the rate of fuel consumption and ranged from 5 or 6 in. to 16 in. Steam was supplied by a small gas-fired boiler. The air blast was preheated at times by passing the air through a heater in which a portion of the gas produced was used for fuel.

The first preliminary trials were made with coke and limestone in order to determine the relative percentages for free-flowing slag. It was found that the computed charges made from the analyses of the material were of no use, since on some occasions the coke ash and limestone were blown away by the heavy air blast. The problem was one of trial rather than calculation and tests were made with different amounts of limestone varying from 4 to 28 lb. per 100 lb. of coke charged. In trials with 20 lb. of limestone per 100 lb. of coke more satisfactory results were obtained, the slag being less viscous than on any preceding trial; it ran from the producer freely and remained sufficiently liquid to spread considerably before solidifying.

In attempting to operate the producer intermittently, as with the fire banked at night, difficulty was experienced from the accumulation of clinker. After shutdowns of one night, the producer was started a number of times on cold-air blast with satisfactory results, but with more than one shutdown there were excessive clinker accumulations. With preheated air, however, a four-day intermittent run was made. It is stated that a producer of this type could hardly be expected to operate intermittently because of its inherent tendency to "freeze" during shutdowns.

Continuous runs of from 75 to 100 hours gave satisfactory results as regards slag and gas. In one test of 76 hours, 20 lb. of coke was consumed per square foot of fuel-bed area per hour, and 15 lb. of limestone was charged for each 100 lb. of coke. The air blast was preheated to 440° F., but no steam was used. The gas was uniform in heat value and of good quality, averaging 31% CO and less than 1.5% CO_2. Some of the time the slag was a little sticky and did not flow very freely, but it was tapped off regularly once an hour and caused no serious difficulty. At the end of the test a layer of hard, flint-like clinker 4 to 6 in. thick was found in the bottom of the producer. Another run with 15 lb. of limestone per 100 lb. of coke lasted more than 100 hours and

FIG. 5. WRECK OF UPPER STEEL RAILWAY BRIDGE, WAUSAU
(Location D, Fig. 1. This bridge was completed only in the spring of 1912.)

FIG. 6. LOOKING FROM THE CITY HALL OVER THE WISCONSIN RIVER, WAUSAU, THE DAY OF THE FLOOD
(Location E, Fig. 1.)

gave satisfactory results. The slag flowed readily throughout the run and at the close of the test the producer was found clean and clear from clinker.

With pre-heated-air blast a more fluid slag is generally obtained, and indications are that higher rates of combustion can be maintained. The use of steam in addition to the air blast seems to have no appreciable effect on the slagging of the ash.

Statistics of Railways in the United States: June 30, 1911

The Interstate Commerce Commission has issued its advance statement of statistics of the railways of the United States for the year ending June 30, 1911, and from this we have prepared the following summary:

MILEAGE—The statement shows that on the date named, the railways aggregated 246,124 miles of line. Of this mileage, there were 23,451 miles with double track, 2414 with three tracks, and 1747 with four to six tracks. Yard tracks and sidings amounted to 88,973 miles, making a total of 362,710 miles of track. This was an increase of 10,944 miles over 1910, and 31% of this increase (3391 miles) was in yards and sidings.

EQUIPMENT—The number of locomotives was 61,327 (an increase of 2380), classified as follows: Passenger, 14,301; freight, 36,405; switching, 9324; unclassified, 1297. The number of cars (exclusive of those owned by commercial concerns) was 2,359,335, an increase of 69,004. Of these, 49,818 were in passenger service, 2,195,511 in freight service, and 114,006 in company service. The equipment per 1000 miles of line was 249 locomotives and 9586 cars. Passenger engines averaged 2,268,067 passenger miles each, and freight engines averaged 6,913,246 ton-miles per engine. Of the total equipment of engines and cars, 98.79% was equipped with train brakes and 99.56% with automatic couplers, as against 97.96% and 99.30% in 1910. Of the 2,195,511 cars in freight service, all but 15,210 had train brakes and all but 9278 had automatic couplers.

EMPLOYEES—The total number of employees was 1,669,809, or 678 per 100 miles of line, a decrease of 29,611 from 1910. These included 129,760 enginemen and firemen, 48,200 conductors, 133,221 other train men. Of the employees, 493,926 were in maintenance of way and structures, 344,112 in maintenance of equipment, and 629,654 in transportation. The salaries and wages for the year amounted to $1,208,466,470.

FINANCE—The railway capital had a par value of $19,208,935,081; of this, stock represented $8,470,717,611 and bonds $10,738,217,470. Of the stock, 32.35% paid no dividends. The dividends amounted to $460,195,376, equivalent to 8.03% on dividend-paying stock.

TRAFFIC—The number of passengers carried was 997,409,882, an increase of 25,726,683. The number carried one mile (or the passenger mileage) was 33,201,694,699; while the number carried one mile per mile of line was 139,191. The freight aggregated 1,781,637,954 tons, a decrease of 68,262,147 tons. The ton-mileage (or tons carried one mile) was 253,783,701,839, a decrease of 1,233,208,612. The tonnage carried one mile per mile of road was 1,053,566, and the number of tons per train-mile was 383.10.

REVENUE AND EXPENDITURES—The average receipts were 1.974c. per passenger per mile and 0.757c. per ton per mile. Revenue per train mile: Passenger service, $1.31; freight service, $2.89; average operating revenue per train-mile, $2.25. Operating expenses absorbed 68.66% of operating revenues, and averaged $7867 per mile of line. Some figures of the revenue and expenses are given in the accompanying table.

TABLE OF OPERATING REVENUES AND EXPENSES OF RAILWAYS IN THE UNITED STATES, FOR THE YEAR ENDING JUNE 30, 1911.

	Thousands of dols.
Operating revenues:	
Freight	1,925,951
Passenger	657,638
Mail	50,703
Express	70,725
Excess baggage, and milk	15,431
Parlor and chair car	5,274
Switching	27,666
Other than transport	24,708
Total (inc. minor items)	2,789,762
Total for 1910	2,750,667
Operating expenses:	
Maint. of way and struc.	366,025
Maint. of equip.	428,367
Traffic	59,166
Transportation	987,382
General	73,689
Unclassified	424
Total	1,915,053
Total for 1910	1,822,630

A Dry Absorber for CO_2 has been developed for use with the Uehling CO_2 meter. The dry absorber is put up in the form of cartons cylindrical in shape and about 3 in. in diameter by 1½ ft. long. The absorbent is a flaky substance called napron, packed in layers within the waxed press-board carton. In use the carton is placed in a cylindrical chamber at one side of the machine, to which the samples of flue gas are admitted through suitable tubes. In the latest machine the percentage of CO_2 is measured by a simple pressure or vacuum gage which registers the changes in vacuum between two orifices. In one form of the instrument, a recording gage of the paper disk type is used and gives a continuous record of percentage of CO_2. The recording vacuum gage idea has been applied also to the Uehling flue-gas temperature recorder and if desired an instrument can be supplied which gives on one disk chart a continuous record of both percentage of CO_2 and flue-gas temperature.

A Classification of City Wastes into those which can be controlled by the municipality and those that remain the property of the producer and therefore subject to sale to a person engaged in collecting such waste, was made in the Common Pleas Court of Cuyahoga County, Ohio, in the case of Stadler versus City of Cleveland, (decided Dec. 8, 1911.) The case is recorded in the monthly report of the Ohio State Board of Health for June, 1912 as follows:

In this suit it was sought to enjoin the City of Cleveland from interfering in the business of collecting dead animals, slaughter house offal and vegetable matter from hotels, restaurants, etc. In substance the court held that the municipality is interfering with the rights of the individual in preventing the collection by him of dead animals and the character of waste known as slaughter house offal, but that the municipality can control the collection of garbage and that class of waste that is of small or no value to the householder, including wastes from hotels, restaurants, etc. In this class of waste the municipality would have the exclusive right to dispose of such matter.

In the case, nothing is said of the authority of a municipality to regulate the manner in which dead animals are collected, or offal, etc., is conveyed over the street, but there is no doubt as to the authority of a municipal council or a board of health to adopt reasonable rules regarding the matter.

New Bridge Shops at Gary, Ind.

A large new bridge and structural steel plant built on a new site in open country offers many opportunities for the introduction of features tending to economy and facility of operation. These are the conditions represented in the new plant of the American Bridge Co., at Gary, Ind., and the special features of the design and equipment of this plant are described in the accompanying article.

In order to increase the facilities for its large and growing western business, the American Bridge Co. a few years ago (and following the completion of its new Eastern plant at Ambridge, Penn.) decided to build near Chicago a large plant for the manufacture of bridge and structural work. This plant, which was put in operation in the spring of 1911, is in the western part of the city of Gary, Ind., 27 miles from Chicago. It is one of a group of large steel industries which have been established in and around Gary, utilizing the sandy wastes along the shore of Lake Michigan for the development of a new manufacturing district, unhampered by the limitations of existing cities and the high cost of property adjacent to such cities. This new industrial city was created as a result of the establishment of the great steel manufacturing plant of the Indiana Steel Co., which was described in our issues of Mar. 4 and Aug. 12, 1909, and which was the first of the group of steel industries above mentioned.

The new plant of the American Bridge Co., as now built, has a capacity of 10,000 tons of finished product per month; its output already has exceeded 8500 tons per month and is steadily increasing in order to keep pace with orders. Provision is made for doubling this present capacity by the erection of additional buildings. About 1200 men are employed in the shops, while the drafting and clerical departments employ about 200 men. A general plan of the plant is shown in Fig. 1, and it will be seen that the principal part is comprised within two main buildings 280x700 ft.; these are placed side by side, and provision is made for two additional buildings (as shown on the plan), all located between a receiving or materia' yard at one end of the property and a shipping yard at the other end.

The entrance is at the southeast corner (at the end of the main street leading to the works), and is appr ached by a steel-arch bridge over the Grand Calumet River, which river forms the southern boundary of the property. The ground is at an elevation about 12 ft. above the ordinary water level, and a large lawn extends from the river to the main driveway which approaches the office building. Beyond this building are the receiving yard, the shops, and the shipping yard, in the order named, the railway-track entrance being at the northwest corner of the property. The plant does not include an eye-bar shop or a foundry, eye-bars and castings being furnished when needed by other plants of the company. The new plant was designed and constructed under the direction of August Ziesing, President of the American Bridge Co., assisted by J. L. Bernard, mechanical engineer; Albert Reichman, civil engineer, and Emil Gerber in charge of construction. George M. Hunter is General Manager, in charge of operation.

Office Building

This structure is of rather unusual size and is of striking appearance, forming a conspicuous feature of the plant, although its architectural design and treatment are quite simple. This building is shown in Fig. 2. It is 46x162 ft. in plan, with three floors and basement, and as the first floor is about 7 ft. above the ground level the entrance is made a significant feature by means of a broad flight of stone steps. The exterior is of light red brick with white stone trimmings and large windows. The building fronts upon a well kept lawn which extends to the river bank and for the full width of the property and thus forms an attractive setting to the building. Across the river is a residence district, and as electric power is used throughout the plant there are no smoky chimneys to foul the air or spoil the view. Incidentally, it may be noted that at one side of the property is a building with restaurant and rooms for the use of the shop employees who prefer to live at the plant, while east of the office building is a baseball ground used by a team organized among the employees.

The building is of steel-frame construction, with concrete floors covered with wood. On the first floor are the offices, auditing and mill-order departments and other business quarters. The two upper floors are for the engineering department, and have four large drafting rooms, each of which can accommodate 40 draftsmen. These rooms are exceptionally light and airy, having rows of large windows, and the building stands in an isolated position. They are about 10 ft. high, and are painted white throughout. For artificial lighting the indirect or reflected system is used. The lamps are of 32 c.p., in groups of four, and are turned upward, each with a reflector beneath it which conceals the lamp and throws the light upon the ceiling. The result is a well diffused light over the entire room, avoiding dark shadows upon the tables. Fig. 3 is a view of one of the drafting rooms. In the basement are rooms properly equipped for the use of the inspectors; there also are the wash rooms, toilet rooms, a shower-bath room, store rooms, and the heating plant.

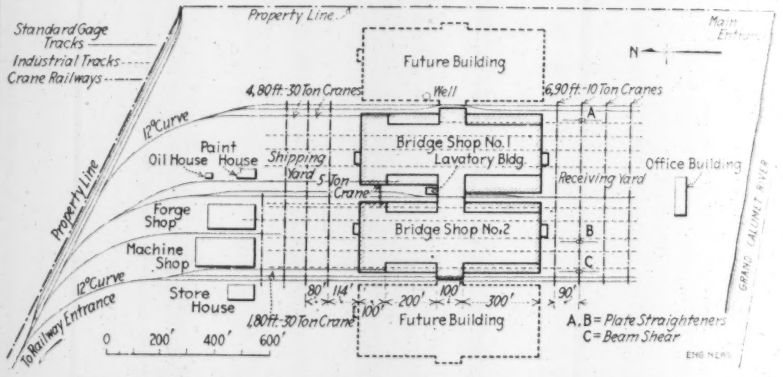


FIG. 1. GENERAL PLAN OF THE NEW PLANT OF THE AMERICAN BRIDGE CO. AT GARY, IND.

Shop Buildings

The two main buildings are of steel-frame construction, with saw-tooth roofs (20 ft. bays) covering the greater part of the area and extending across the connecting building. In each building, however, the north end (for finishing and assembling) is covered by a transverse truss roof, while the departments or shops along each side have shed roofs. The roof construction is shown in the sections, Fig. 4. The main columns are composed each of a pair of 24-in. I-beams and a web-plate 40 ft. long, forming an H-section 24x28 in. The columns are spaced as shown on the plan, and are connected by longitudinal trusses upon which are mounted the transverse trusses of the saw-tooth roof, as shown

FIG. 2. OFFICE BUILDING OF THE AMERICAN BRIDGE CO., GARY, IND.

in Figs. 4 and 5. The headway under the traveling cranes is 27 ft. in the main part of the shops and 19 ft. in the side bays.

Curtain walls of reinforced concrete are built, as a rule, to the level of the windows, the upper part (which is largely glazed) being sheathed with galvanized corrugated iron. The template shop, however, has reinforced-concrete walls for its full height (including a wall isolating it from the main shop); this is done as a measure of fire protection in view of the amount of wood stored and used here. This shop has steel-frame galleries suspended from the roof trusses. The power house also has concrete walls, and the separate storehouse is of concrete construction. The roofs are sheathed with 6x1⅝-in. pine, which is covered with corrugated iron, except that slate is used over the template shop and power house. The floors are mainly of cinders over the sand filling, but concrete is used in the power house. A wood-block floor is used in the storehouse; the blocks are of large size, made by cutting up the sound parts of old timbers. In the two main buildings, roof lights and ventilators are provided along the saw-tooth ridges, while the roofs of the transverse bays at the north end have skylights along the hips and in a low monitor at the center. The walls and steel work of the interior are painted white to increase the lighting effect.

SHOPS AND SHOP EQUIPMENT

As already explained, and as shown in Figs. 1 and 5, the main part of the shop plant is comprised within two main buildings (known as bridge shops No. 1 and No. 2), each of which is approximately 283x700 ft. These buildings are parallel the space between them being 40 ft. wide at the south end and 67 ft. at the north end. At the middle they are connected by a lateral building 100 ft. wide, which forms an important feature of the arrangement. It serves not only for the transfer of material, but provides convenient space for the temporary storage of partly finished material which cannot be handled immediately at its next process or which must be held until other material is ready. It provides storage also for material needed to maintain a steady source of supply for a department which is required to work to full capacity. This arrangement prevents the congestion due to piling material near tools which are not ready to handle it, and as the transfer building is equipped with cranes the material is readily put out of the way or picked up when wanted.

Along each side of the main part of the buildings are shops for special classes of work, as indicated on the plan. These include the template, bending, rivet-making, light work, detail and beam shops, and the power house. There is one receiving office, in the south yard; but each main shop has a shipping office at the north end. Beyond the main buildings and in the north yard are the machine shop, 116x216 ft.; forge shop, 100x180 ft.; storehouse, 60x100 ft.; paint house and oil house.

Bridge shop No. 1 (at the east side) is intended for the heavier work. The punch and shear equipment is at the south end, and in addition to a number of machines for plate and I-beam work it includes the following tools: 50-ft. plate-edge planer, 10-ft. plate shear and 10-ft. and 5-ft. multiple punches. There are also two hydraulic bending presses of 400 tons capacity. The north end of the building is used for assembling and riveting, and has rows of 12x12-in. skid beams (capped with steel rails) on which work is assembled. In the riveting bay there are two 100-ton and two 60-ton hydraulic riveters; these are set in the floor and are served by traveling gantry cranes 14 ft. high, in which the work is slung. The gantries are of 40 and 15 tons capacity for the larger and smaller riveters, respectively. Fig. 6 shows one of these gantries, with a hydraulic riveter at the right; behind this are the rivet bins and crane. There are also a number of pneumatic jaw riveters slung from overhead travelers. In the reaming department are reaming gantries (each with six radial arms); and in the finishing department are arranged rotary planers, boring machines for pin holes, etc. In shop No. 2 the equipment is of a generally similar character. It includes a 120-in. plate shear (with 35-hp. motor), double angle shears, coping machine, 5-ft. and 8-ft. multiple punches, etc. Hydraulic and pneumatic riveters are employed here, also.

The template department, in shop No.

FIG. 3. DRAFTING ROOM IN THE OFFICE BUILDING OF THE AMERICAN BRIDGE CO.
(Note the inverted electric lamps and reflectors for diffused lighting.)

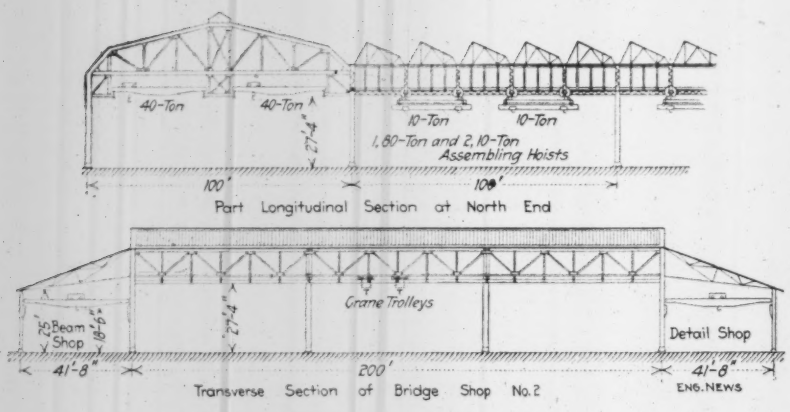


FIG. 4. SECTIONS OF THE MAIN BRIDGE SHOPS

1, is 70x280 ft. and is equipped with wood-working machinery and template-making benches. For storing lumber and templates there is a gallery, the steel frame of which is suspended from the roof trusses. The rivet-making department (also in shop No. 1) is equipped with oil-heated rod furnaces, four rivet machines and a bolt-heading machine. Around the floor are a number of tall steel-storage bins, for rivets and bolts of various sizes; each bin has a hinged chute by which the contents may be delivered to cars on the industrial-railway tracks. The 10-ton 40-ft. traveling crane in this department has a hopper and spout beneath one end of the girder, so that a skip or keg of rivets hoisted from the floor can be dumped here to deliver its contents into the desired bin. The bins and the crane (with its spout) are to be seen at the right in Fig. 6.

The machine shop has a 60-ft. central bay and two side bays. The former is left clear for assembling and is served by a 25-ton overhead traveling crane. At the south end is a heavy concrete foundation or erecting floor for the assembling of drawbridge turntables. This is 65 ft. diameter and 2 ft. thick, and has embedded in the top a number of timbers 12x12 in. which are arranged radially and provide for bolting down the work during erection. The machine tools are arranged in the side bays; they include a 72-in. planer, 10-ft. open-side planer, 16-ft. boring mill and an equipment of lathes, drills, shapers, and other tools. Each of these bays is served by two overhead revolving cranes. The forge shop has open forges, oil-hardening furnaces, bolt-cutting machines, and a 1000-ton steam-hydraulic press for bending plates, etc. Steam for this is furnished by a single water-tube boiler of 150 hp. The shop is served by a 5-ton overhead crane of 60 ft. span.

HANDLING MATERIAL

The buildings and machines are arranged with a view to the systematic movement of material from the storage or receiving yard through the shops and the several processes to the shipping yard. Railway tracks are laid through the yards, as shown, and spurs enter the north ends of the main buildings, so that assembled material can be loaded directly upon the cars. Besides these tracks there is an industrial-railway system of 3-ft. gage; several of these tracks extend through the main shops and yards, while branches lead to other departments. Some of the yard tracks have three rails to serve both railway and industrial cars. These latter are simply push cars, and the tracks have a slight down grade to the north to facilitate the moving of loaded cars. All the standard-gage and mixed-gage tracks are laid with steel ties. In addition to the numerous cranes noted below there is a steam locomotive crane with a 38-ft. boom (with 15 ft. extension) and a lifting capacity of 15 tons. This is used for miscellaneous work, and serves also an auxiliary material yard on the west side of the main shops. For moving railway cars about the plant there is a 45-ton saddle-tank locomotive of the 0-4-0 class.

SHOP HANDLING—The crane equipment of the shops is very extensive, as will be seen by reference to the plan and sections, Figs. 4 and 5. There are overhead traveling cranes of varying size and capacity to suit the different classes of work, while each large machine has a derrick crane to support the material being operated upon. This consists of 25-ft. horizontal boom riveted to a steel mast which is pivoted on a pedestal in the floor (or on the top of the machine frame) and in an overhead member. The boom swings radially and on it rides a trolley equipped with hook (for attaching slings, etc.) or a 2-ton chain or electric hoist. In the assembling departments there are a number of overhead electric traveling cranes of 20 ft. span, on runways which extend across the building and through the connecting transfer bay so as to serve both buildings. Each crane has a bridge girder (which is beneath the runways), but instead of being fitted with a hoisting trolley, it has two fixed hoisting drums with cables. From the cables is suspended an I-beam which can be raised and lowered

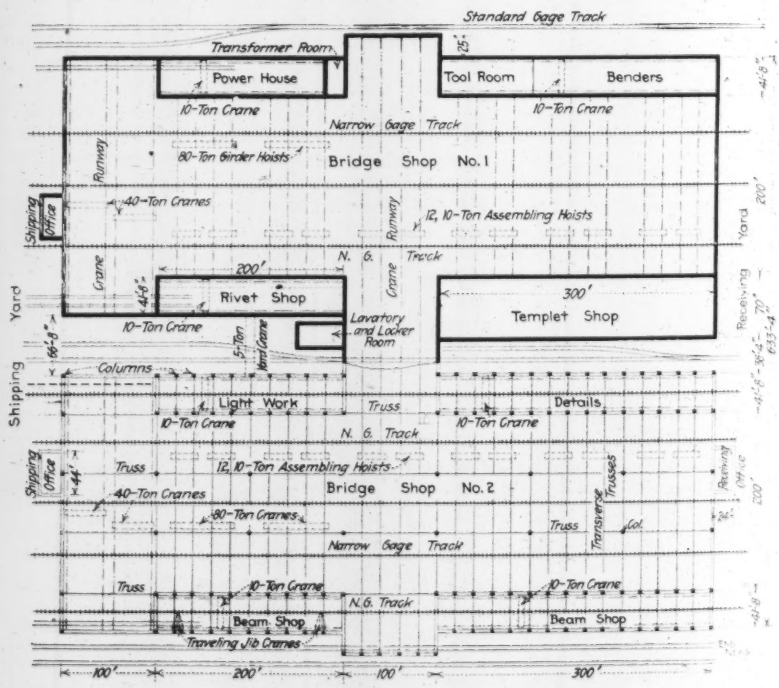


FIG. 5. PLAN OF THE TWO MAIN BRIDGE SHOPS

(The plan of shop No. 1 shows the foundation walls and the crane runways with overhead cranes. The plan of shop No. 2 shows the arrangement of columns and trusses, with the position of overhead cranes.)

as desired. On the I-beam run chain hoists or trolleys fitted with hooks for slings. These assembling cranes cannot only travel along their respective runways, but can move through from one runway to another. Most of them are of 10-ton capacity, but some are of 20 tons, and two (100 ft. long) are of 80 tons capacity. These assembling cranes and the derrick cranes at the machines are shown in Fig. 8. In each shop, the assembling or finishing department at the north end is served by two parallel 40-ft. traveling cranes of 40 tons capacity; the runways of these are carried from the roof trusses by hangers, so that the floor is not obstructed by supporting columns (Fig. 4).

The machine shop has in each side bay two parallel 6-ft. runways, on each of which travels an overhead jib crane of special design, Fig. 9. In the rectangular frame of the carriage is a circular frame or turntable for the leg of the jib, this leg projecting below the runway and carrying a horizontal boom 6 ft. in length, on which rides a 2-ton hoisting trolley. The beam shop (in shop No. 2) has two similar cranes, as shown in Fig. 5.

YARD HANDLING—Railway cars bringing material are run directly to the receiving yard (which is about 750x270 ft.), where their loads are picked up and distributed by means of six 10-ton traveling cranes of 90-ft. span on three parallel runways 743 ft. long. The runway columns or bents are 40 to 50 ft. apart. Each crane has two 5-ton hoisting trolleys. Fig. 10 shows these yard cranes. The electric cables crossing the yard are supported on steel towers built on the runway bents. The material is piled on skid beams of 12x12-in. timbers capped with steel rails or channels. As material is called for by requisitions from the shops, the cranes sort it out and load it on trolleys running on the industrial tracks. These carry it into the shop, to be distributed by the shop cranes. Material completed in the assembling department may be loaded directly upon cars on spur tracks by means of these cranes.

In the shipping yard (750x160 ft.), there are four 30-ton overhead cranes on two parallel runways of 80-ft. span, having a travel of 734 ft. Adjacent to these is a runway of the same span, but only 350 ft. in length, for a 30-ton crane which serves material going to and from the machine and forge shops. The space between the two main buildings, which may be utilized for storage, is served by a 5-ton 66-ft. traveling crane. Beyond these yard cranes is an assembling gantry of 125-ft. span, with 540 ft. travel, and having a headway of 25 ft. beneath the truss bridge which carries the two hoisting trolleys of 75 tons capacity each and a 15-ton auxiliary hoist. This yard is used for painting and assembling, and for supporting the work it is equipped with lines of 24-in. I-beams spaced about 5 ft. apart and anchored to concrete longitudinals.

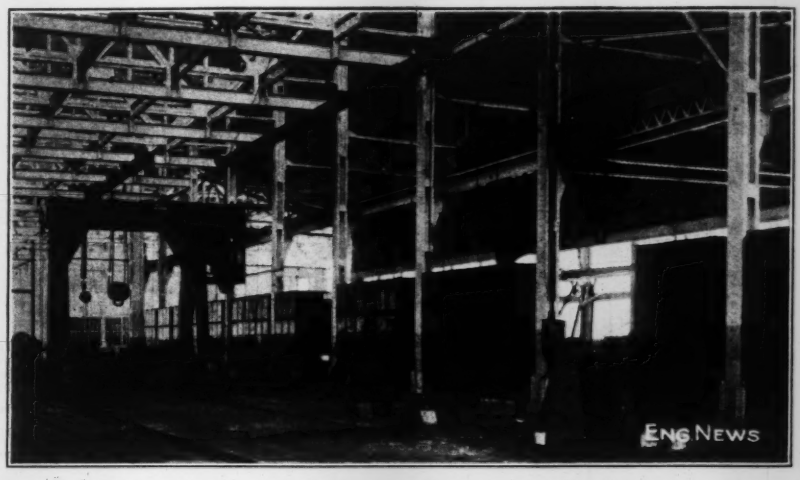


FIG. 6. RIVETING DEPARTMENT

(The gantry carries work while being operated on by the hydraulic riveters, one of which is shown at the right. Behind this is a row of rivet storage bins served by a crane which travels over the rivet making department.)

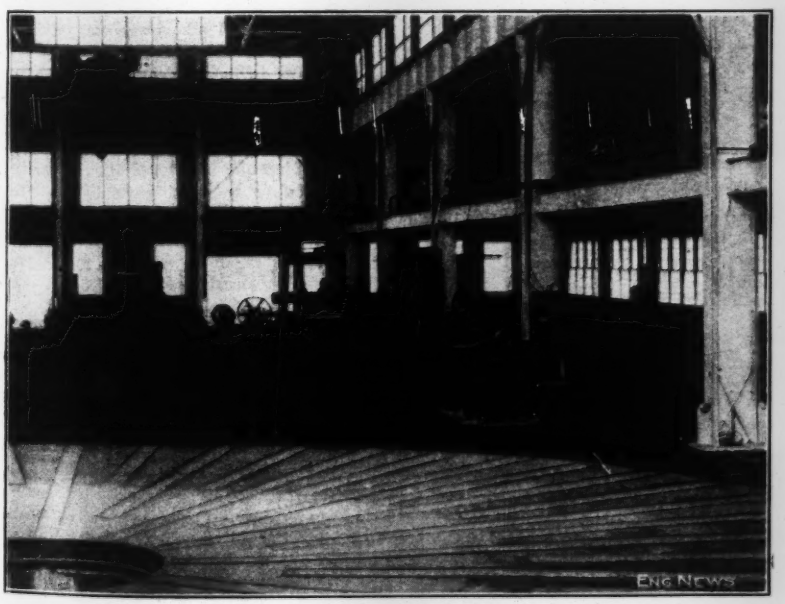
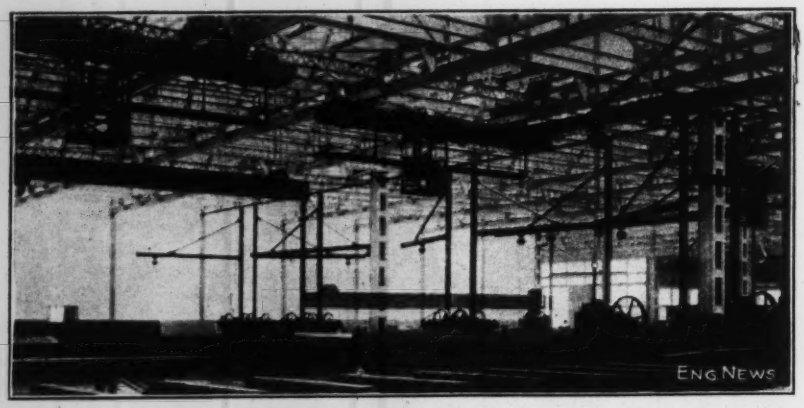


FIG. 7. INTERIOR OF MACHINE SHOP, SHOWING CIRCULAR CONCRETE FOUNDATION FOR THE ASSEMBLING OF TURNTABLES OF DRAWBRIDGES

POWER AND MISCELLANEOUS EQUIPMENT

All machinery is operated by electricity, large tools having individual motors while smaller tools are driven in groups. Current is obtained from the generating plant of the Indiana Steel Co., two miles distant, the three-phase 25-cycle 22,000-volt current being transmitted by an overhead line and delivered to the transformer room of the power house, 40x220 ft., which forms a part of the main bridge-shop. Here the current is stepped down to 6600 volts and delivered to two rotary converter sets of 710 hp. and 440 hp. The power plant includes the following: 1, two air compressors furnishing air at 100 lb. pressure for the riveters and other pneumatic tools, each compressor driven by a 6200-volt alternating-current motor of 400 hp.; 2, a motor-driven compressor supplying air at 15 lb. pressure for the rod and rivet-heating furnaces; 3, two triplex hydraulic pumps driven by direct-current motors of 150 hp. (450 r.p.m.), for operating presses and large riveters, the 1500 lb. working pressure being maintained by two accumulators; 4, a motor-driven centrifugal fire pump of 1500 gal. capacity; 5, switchboard and electrical equipment. For handling the machinery there is a 10-ton overhead crane. All cranes are operated by direct-current motors. For distribution through the shops, for power and lighting, 220-



8. Assembling Hoists and Derrick Cranes

Fig. 9. Overhead Revolving Jib Cranes in the Machine Shop.

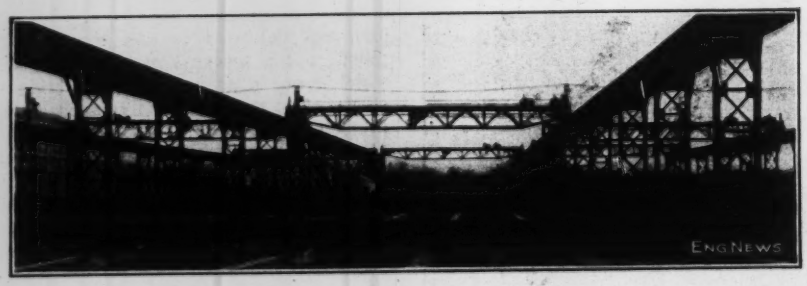


Fig. 10. Overhead Cranes in the Receiving Yard

(Each of the three parallel pair of runways carries two 10-ton cranes of 90-ft. span.)

volt 25-cycle three-phase current is employed.

Water supply is obtained from the Gary city water system, while water for boilers and industrial purposes is drawn from two concrete-lined wells 20 ft. diameter sunk to depths of about 35 and 28 ft., respectively, into the sand and gravel formation. The power house, template shop and machine shop are heated by steam, by means of pipe coils for direct radiation, the steam being furnished from boilers at the plant. No provision is made for heating the main shops, but in very cold weather open salamanders are installed on the floors. Ventilators are provided along the roofs. The electric-lighting system includes arc lamps for the yard and over the main floors, and incandescent lamps to serve the machine tools and bench work. Wash basins and lavatories are arranged at different parts of the plant, and a lavatory and [illegible] room (with heating plant), 32x48 [illegible] is built in the space between the two main buildings.

Emergency Welding of Broken Parts of Dredges*

By S. E. Lawrence†

The continuous operation of dredging plants, day and night, and the extreme usage that some of the machinery is subjected to are conducive to many breakdowns, which are very expensive both in repair cost and more especially in delays and crew costs while parts are being repaired.

Such accidents are provided against as far as they can be ordinarily foreseen by keeping on hand such duplicate parts as may be expected to give way under usual conditions, and each plant in this district is equipped with a small machine and blacksmith shop to handle emergency repairs. Such precautions do not, however, provide for the larger breaks and the extraordinary accidents, and it is in this particular field that the Thermit welding process has been of service in several instances.

The first time this method was employed by this office was in the repair of the low-pressure connecting rod of the 550-hp. triple-expansion engine directly connected to the dredging pump on the 20-in. U. S. pipe-line dredge "Col. A. M. Miller."

This fracture was an example of the sudden development of an invisible flaw made in the original forging of the part. This engine had been in constant operation for several years and no precaution had been thought necessary to keep an extra rod on hand.

As it would delay the dredge for an indefinite time to secure a new part from the factory, and also several days at least to machine one in a local shop, it was determined to try and reweld the broken fork. Only fair results were obtained, and it was not thought advisable to use the rod. Then it was that the Thermit process was resorted to. About 1 in. of metal was removed and the parts fastened to a bedplate in as perfect alignment as possible. The weld came out of the sand in good condition and, after removing gate and riser, the part was placed in the engine without further machining and was so used with best of results.

The second instance in which this method of repair was made use of was in the repair of one of the propeller shafts of the seagoing hopper dredge

*From "Professional Memoirs, Corps of Engineers, U. S. Army and Engineer Dept. at Large," July-Aug., 1912. Vol. 4, No. 16.

†Junior Mechanical Engineer, U. S. Engineer Dept., Galveston, Tex.

"Galvanizing." This was hardly a weld in the common acceptance of the term, as there was no uniting of severed parts, but it served as an illustration of the varied uses that this method can be put to.

While at work at the mouth of Galveston Harbor a wire cable became entangled about one of the shafts in such a way as to wear a groove in it about 1¼ deep and 4 in. wide. This weakening of the 10-in. shaft necessitated its removal, a spare part being substituted. The local shops did not afford a lathe of sufficient size to handle the removed shaft, and other methods of repair other than the conventional ones had to be resorted to.

Two processes suggested themselves, the oxy-acetylene process of autogenous welding and the Goldschmidt Thermit process, and representatives of both methods were asked to submit proposals for the filling of the groove cut by the entangled cable.

Upon receipt of the proposals, the oxy-acetylene bid proved the lower and a contract was awarded for the filling in of the cut with new metal by their method.

To facilitate matters the shaft was raised on concrete piers, the top of the piers forming a socket in which to turn the shaft more easily. This turning was accomplished by means of a tackle and rail.

The apparatus was put in place and the shaft preheated with charcoal and covered with asbestos to retain the heat as much as possible. The work was done under extreme physical conditions, the great heat requiring frequent relays and changing of men, it being almost impossible for a man to stand close enough to the cut to operate the burner for very long at a time. When the circle was at last complete and inspected, the ring of the metal melted into the cut was shut to be separated from the metal of the shaft in places, the bond was insufficient to strengthen the weakened place, and the material so placed was easily removed. The failure was due mainly to the large radiation and conducting of the heat from the particular part where a bond of metal was desired, and to the severe physical strain. Smaller parts have been successfully handled here.

The Thermit exponents were then given a chance to fill in the worn place. The groove was carefully filled with wax and an adjustable flask placed around the worn part and the mold. Air was supplied from a derrick car, the derrick also being utilized to suspend the crucible containing the charge. The preheating was accomplished by gasoline blow torches and the wax was carefully removed and the mold cleaned by compressed air.

The reaction was perfect, and the result was a complete welding of the new metal into the groove. Precautions had been taken to provide a large riser and gate to cover the shrinkage and to insure solid metal in the worn part, as the top metal may be in some cases more or less porous. When the mold was removed, very satisfactory results were found. The removal of the extremely tough surplus metal was the most difficult part of the work. The gate and riser were finally removed, and outside of a few marks the weld was unnoticeable. Some concern was felt about the chances of warping the shaft when such an intense heat was suddenly applied in a comparatively short length, but such fears were dispelled when no appreciable change in the alignment was evident.

No machine finishing was necessary in this case, as the portion of the shaft affected did not come upon any bearing surface. Herein consisted the efficiency of this particular method, as there was no machine of sufficient size to handle this length of shafting available in this immediate locality, which would have barred the ordinary schemes of repair.

The third incident of interest in this district was the repair of the crankshaft of the main engine of the U. S. Engineers pipe-line suction dredge "Captain C. W. Howell."

The crankshaft of this 12x22x14-in. compound engine, directly connected to a 12-in. dredging pump, was 5½ in. in diameter. A crack was discovered in the low-pressure crankpin, and a careful investigation showed that instead of the characteristic fracture the crack ran into the web and back again around the pin. This precluded all the ordinary schemes of replacing the broken pin by shrinking in a new one, as the web did not have sufficient remaining metal to make such a repair safe.

The dredge was operated until arrangements could be made for a Thermit weld, and on the repair day the plant was shut down and the shaft removed to a shop. It was found to be entirely broken off. Part of the pin was machined off, leaving about an inch of space between the web and pin when the parts were aligned and fastened to a bedplate.

The mold was repaired in the usual way, and the ends to be united heated to as high a temperature as was safe. There was no hitch in the pouring of the crucible and, after cooling over night, the mold was removed in sections to prevent uneven contraction.

When the gates were removed and the complete shaft placed in a lathe the nice allowance for shrinkage, etc., was evidenced by the fact that scarcely any refinishing was necessary on the thrust collars of the shaft. The pin was turned up and the surplus metal removed and web reshaped to original dimensions without changing the balance of the shaft.

A total of four days was lost by the plant because of this repair, most of the delay being due to the distance of the dredge from the shop. This shaft continued in constant use without any evidence of the repair whatever, and was in use when this dredge was lost a year after on the Texas coast.

An idea of the saving effected in this instance may be obtained from the fact that a new shaft ordered rushed at once from the factory at a cost of $465 was not ready for shipment 90 days after receipt of order, as compared with a charge of $150 and a delay of four days for the Thermit weld.

The necessity of skilled handling and placing of parts to be welded can not be too forcibly emphasized, as the chances for ruining a part are greater from mishandling than from failure of the weld, and much unnecessary finishing work is prevented by careful attention to the mold conforming exactly to the desired shape of the part to be repaired.

The hard-driven machinery of dredging plants, with their interdependent individual machines, offers an excellent field for economic employment of this method, and it will very likely play an important part in cutting down long delays brought about by extraordinary accidents.

In the Mitering Lock Gates of the Panama Canal a somewhat novel device has been adopted in order to insure a tight fit between the bottom of the gates and the fixed sills on the masonry. The original plans provided for a heavy timber fixed to the masonry and a smaller timber fastened along the bottom of the gate leaf. When the gate is closed these two sills should be in contact. Owing to changes in temperatures and consequent slight variations in the lengths of the gate leaves, it is possible that an absolute fit of one timber against the other will not at all times be maintained. This may also arise from slight changes in the operation of the machinery.

Without making any changes in the timbers as originally specified, a sill consisting of a rubber flap 4 in. wide and ½ in. thick, and fastened to the gate by an angle iron has been added. This seal will at all times fit closely, even though there be a slight gap between the fixed sill and the leaf. Experiments made at the Gorgona shops seem to indicate that the design will fulfill its purpose perfectly.

In order to protect the inside of the bottom of the leaf from corrosion and to drain it of any accumulated water, a filling of coke concrete is being placed on the bottom of each gate leaf. The seepage water is collected in four sumps, from which it will be pumped out by a pumping system to be installed in each gate.

Coke is used as being lighter than a solid concrete filling. The method used consists of first coating the steel work with a wash of cement, then packing in the coke, broken into small pieces, to a height of 5 in., and pouring cement grout over it, so as to fill the spaces between the pieces of coke. An impervious coating of cement about 1 in. thick will then be laid over the coke, pitched to proper surface to drain into the sumps.—"Canal Record."

A Compressed Air Concrete Mixer and Conveyor

A concrete plant in which the entire mixing and conveying operation is carried on by the use of compressed air has been in successful operation for some time on the McCall Ferry power plant of the Pennsylvania Water & Power Co., at Holtwood, Penn. This power house, which was described in ENGINEERING NEWS Sept. 12, 1907, p. 267, was originally designed for 10 hydroelectric units, but it was put in operation with only five such units. The projected increase in size is now being made and requires not only the installation of new turbines, but also the construction of that part of the power house, including overhead construction and pit arches, for the new portion of the plant. In accordance with the original design all this work is of concrete.

The new structure is being built by the company with its own forces under the direction of L. H. Eichelberger, the construction superintendent, and the design and operation of the compressed-air mixing and conveying plant are due to Mr. Eichelberger.

The plant consists essentially of an air compressor, a material storage house with connections to separate bins for the different materials, an automatic measuring device, an inclosed tank into which the materials and water are placed to be mixed by the agitation of a compressed-air stream and a delivery pipe leading from this tank to the place of deposit. The compressors, storage house and mixer are permanently located at a place convenient to the railway siding so that material may be easily brought there, but the delivery pipe can be led to any place on the work where it is required.

DESCRIPTION OF PLANT

Figs. 1 and 2 show the general layout of the plant. At the extreme left is the compressor with pipes leading to the mixer as shown. The mixer is located under the storage house in line with the hoppers from the various material bins, which hoppers empty upon an electric motor driven belt conveyor, which delivers the materials to the upper hopper of the mixer.

STORAGE HOUSE—The storage house is shown in Fig. 1. It is a rough building with an overhead track leading directly from the railway siding over the various bins, which are divided, as shown, into bins for stone screenings, screened sand, rough sand, small stone and rough stone, respectively. At the bottom of each bin is a hopper as detailed in Fig. 3 for some of the bins. These hoppers are built so as to contain units or multiples of a unit amount. The rough-stone and small-stone hoppers contain twice as much as the sand or screening hoppers, and the unit is twice the contents of a sack of cement, so that for the mixture used in the work,

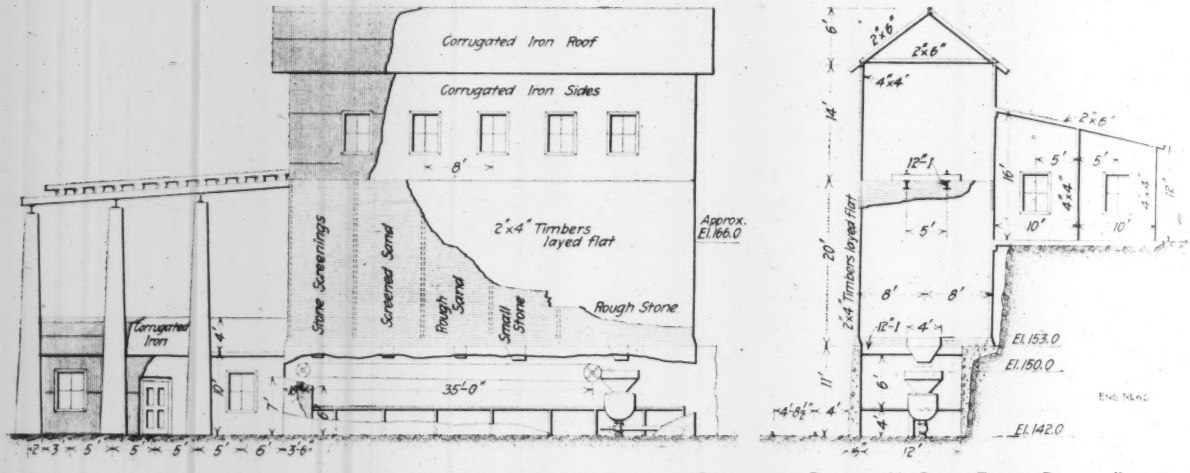


FIG. 1. GENERAL LAYOUT OF COMPRESSED AIR CONCRETE MIXING AND CONVEYING PLANT, MCCALL FERRY POWER PLANT

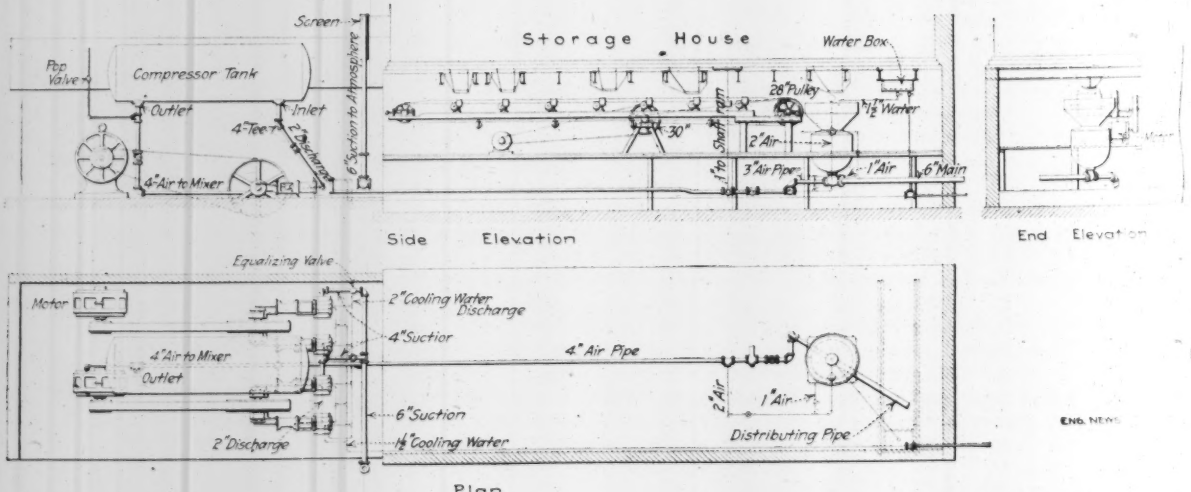


FIG. 2. DETAILS OF THE MIXING PLANT

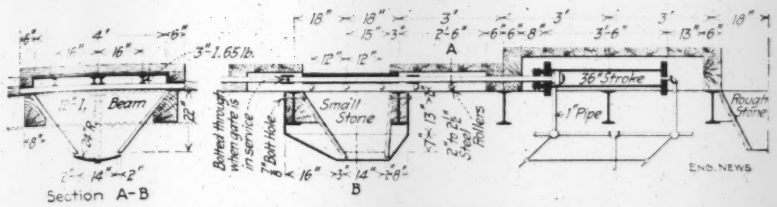


FIG. 3. DETAILS OF HOPPERS AND GATES

1:2:4, the sand hopper and the stone hopper each is filled once to form the proper mixture. For other proportions of mix a different arrangement may be used.

Each of these hoppers is closed at its upper part by a gate sliding horizontally, with all the gates actuated by a single horizontal shaft leading to a piston at the extreme right, as shown in Fig. 3. Each of the gates is connected to this shaft by a slip bolt, as shown in the figure. The piston is in connection with an air pipe leading from the compressor tank, so that by pulling the lever by the side of the mixer the proper gates which have been locked by the slip bolt are opened and the hoppers are filled to the proper amount. The operator can then close them by shoving back the lever. In mixing the concrete different materials are used in different parts of the work and the operator empties the hoppers designated for the particular work in hand by pulling the radial bottom door, shown in Fig. 3. At the same time, the cement, which is stored in sacks at the extreme right of the storehouse as shown, is led to the mixer by a chute from above and the water is fed from a barrel immediately alongside the mixer. In feeding the mixer, therefore, the one man controls the material from his place by the mixer and an exact proportion is assured.

MIXING TANK—The mixing tank shown in Fig. 4 and in the views in Figs. 5 and 6 is the one in use at the McCall Ferry plant. Since putting it into operation several revisions in the design of future mixers have been made, the main one of which, a conversion from a hemispherical bottom to a conical bottom, is shown in dotted lines on the drawing. The mixer consists of a conical upper hopper leading through an opening, which can be tightly closed, into a lower tank where the mixing operation takes place. This lower tank in the original design is a cylinder joined above a hemisphere with an opening at the bottom through which the material is delivered to the conveying pipe. It is built of wrought iron, 3/8-in. material being used for the tank, hopper and doors and 1/2-in. material for the top head of tank. It was tested before use to stand 175 lb. per sq.in. pressure.

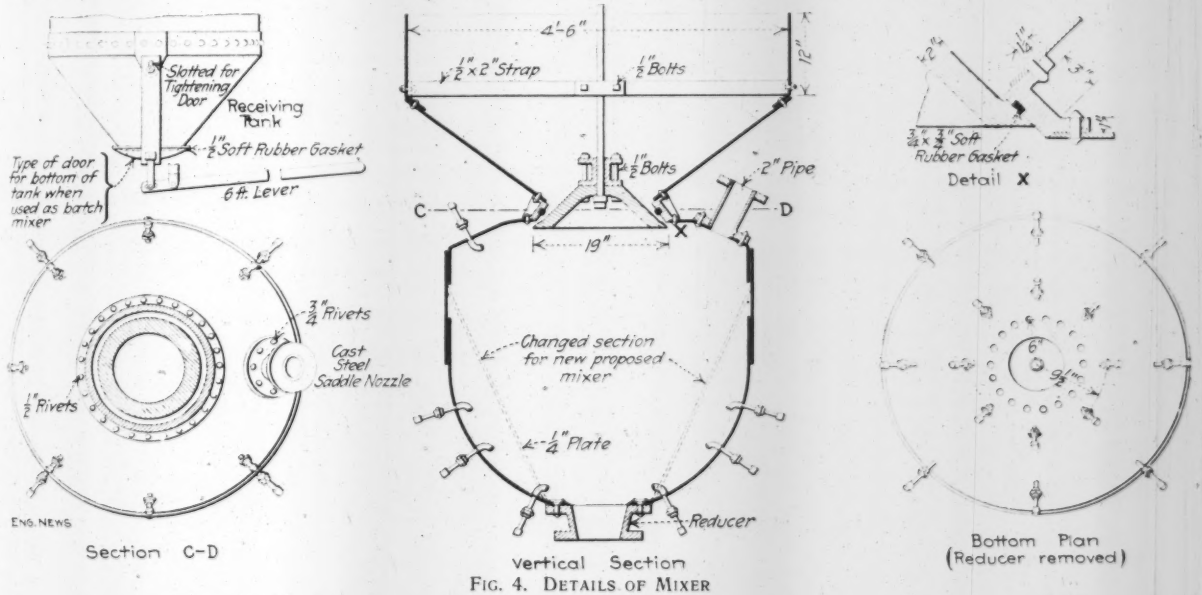


FIG. 4. DETAILS OF MIXER

In addition to the main entering pipe, shown at the upper right-hand shoulder of the lower tank, through which the main force of the air is applied, there are a number of holes tapped for 1/2-in. pipe in the upper shoulder and the lower part of the periphery of the tank. In these holes are placed 1/2-in. pipe turned on an angle so as to deliver air in a circumferential line, thus causing a whirling motion of the material inside the tank. These pipes are all connected to one of the lines of pipe from the compressor, though this connection is not shown in the drawing. They may be noted in the views in Figs. 5 and 6. The bottom of the tank is not closed by a gate, but opens directly into the conveying pipe, which, however, takes a right-angle turn to a horizontal position immediately below the tank. In line with this conveying pipe is a 3-in. pipe from the compressor, which operates as noted below, to force the mixed concrete along the pipe.

In operation the material is dumped by the belt conveyor, as noted above, into the upper hopper, which is closed tight with the cone valve shown. When the materials have been placed in the hopper the cone valve is dropped, by a horizontal lever (not shown in drawing) connecting to the vertical rod attached to the valve, into the lower hopper and the valve is closed at the same time air is turned on to the main 2-in. pipe in the upper right-hand shoulder of the tank and to the small whirling jets noted above. The whirling jets tend to mix the material, while the air from the 2-in. pipe forces the concrete into the conveying pipe directly in front of the 3-in. air jet below, which blows the material through the conveyor pipe to the end of the line.

CONVEYOR PIPE—The conveyor pipe in use on this mixer at McCall Ferry is the ordinary 6-in. wrought-iron pipe, flange connected. On leaving the mixer it takes a slight curve in a horizontal plane and continues for some 300 ft. approximately level to a juncture point where it is led to the different places needed on the work. At this juncture point there is a vertical pipe leading to the top of the power house about 100 ft. above the level of the lower pipe and a horizontal continuation leading to the penstocks and turbine settings. For the end of the delivery pipe originally a box with a curved surface opposite the end of the pipe was devised, but it was soon found that it was just as easy to use a 14-in. T joined to the end of the 6-in. pipe with the hori-

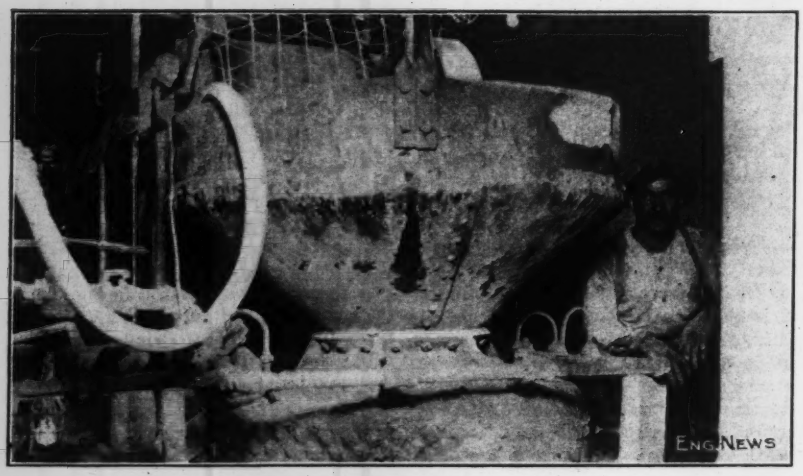


FIG. 5. VIEW OF UPPER HALF OF MIXER, SHOWING CHARGING HOPPER AND WATER JETS

zontal branch opposite the delivery end closed with an iron plate, backed on a wood bulkhead. The material hitting this end soon built up a small cushion of concrete and formed a natural curve around which the concrete was delivered to the vertical drop pipe of the T.

OPERATION OF PLANT

When the concrete plant was first installed there were available only two compressors, each having a capacity of 300 cu.ft. at 100 lb. pressure, and in addition to the concrete plant a number of drills and repair-shop machines had to be run. Since then another compressor has been installed, so that the machine may be worked to its full capacity. The rated capacity of the mixer is ½ cu.yd., and, working at a minimum distance of 380 ft. with a maximum of 490 ft., the machine has uniformly been mixing and conveying at the rate of 40 batches, that is, 20 cu.yd., per hour. It probably could do better than this if more air were available, as the speed of delivery is only restricted by the speed of getting the materials out of the hoppers into the mixer.

For this work the gang consists of one foreman and five laborers, three of whom are required to operate the mixer. The fourth is used at the discharge end of the pipe as a signal man and for the cleaning of the chute, and the fifth man spades the concrete in the forms. There is a reverse-acting electric signal provided at the mixer and the place of deposit. When the mixer foreman receives the signal from the other end of the line he lifts the cone valve on the mixer and the mixed material is delivered within 30 sec. to the other end of the pipe. About every 20 batches the pipe is blown through without any material, so as to clean out any concrete which may have lodged at various points along the line.

The concrete delivered is of uniform consistency and appears to be a remarkably dense mixture, although the period of mixing is so short. Mr. Eichelberger states that he has successfully placed large quantities of both concrete and mortar of widely varied degrees of liquid consistency with equal facility, but that a wet mixture is preferable in reducing the wear on the equipment probably because of the lubricating qualities of the water. The large-size stone used on most of the concrete will pass a 3-in. ring, so it will be seen that the mixer and conveyor is for concrete and not for grout alone.

Up to the time when 2200 yd. of concrete had been placed there was no apparent wear on the mixer itself or on the straight part of the 6-in. delivery pipe. At the curve of the delivery pipe, however, the outer surface seemed to wear very rapidly, and a design has been made in which the outer surface is provided with a flange, which can be replaced from time to time. There seems to be no difficulty in raising the concrete to a height of 100 ft., and the delivery at that point is equally efficient and rapid with that on a horizontal line from the mixer.

The mixer was first designed as a batch mixer to deliver directly from its bottom opening to buckets and conveyed by the usual derrick or car methods. Mounted and operated for such a batch mixture, it is placed higher and the large bottom T removed and replaced with the swinging door detailed in Fig. 4. This door holds the materials in the mixer until air is admitted through the mixing jets for a duration of about 10 seconds. The air is then shut off and the door opened to release the mixed concrete. In this way only a small amount of air is required.

Another air-saving device was used on part of the work but was discarded on account of several defects. It is expected, however, that it can be brought to a higher state of perfection. This consists of a receiving tank at the delivery end of the concrete pipe which cages the air and returns it to the compressor tank. In operation it delivered air back to the tank at about 40 lb. pressure.

For some new mixers which are being built there have been a few changes, the principal of which is the revision of the lower part of the tank to the conical shape shown in dotted lines on the drawing. This allows of more rapid and easy chuting of the concrete into the lower pipe. These new mixers are being designed for a 1-cu.yd. size, and it is expected that the delivery of this amount will be equally satisfactory as for the ½-cu.yd. mixer now employed.

The advantages claimed for the device are rapid and economical mixing, together with very economical delivery. In addition for such work as is being done at Holtwood the presence of the usual derricks or car tracks would seriously interfere with the form work and the operation of the present plant. On the other hand, the delivery pipe can be easily led wherever required without interfering with any existing work.

FIG. 6. LOWER HALF OF MIXER, SHOWING PIPES LEADING TO MIXING JETS

Progress on the Canadian Pacific Railway Co.'s Irrigation Works at and near Calgary, Alta.

Engineers interested in irrigation works or dam construction who are fortunate enough to be passing over the Canadian Pacific Ry. to or from the Pacific Coast by the way of Calgary, Alta., will do well to stop at that city and see the immense irrigation works being built by the Canadian Pacific Ry. Co. The point of commanding interest at present is at Bassano, some 80 miles to the east of Calgary. The irrigation works in the immediate vicinity of Calgary are already completed and, although on a large scale, are simple in character; while those at Bassano comprise a composite dam of reinforced concrete and of earth, totaling about a mile and a half in length, besides a deep canal cut, a unique flume and hundreds of miles of main and subsidiary canals. The earth work, chiefly excavation, at Bassano and on the canals leading from there aggregates some 20,000,000 cu.yd.

A general description of the vast irrigation enterprise of the Canadian Pacific, which stretches for 140 to 150 miles east of Calgary, was published in ENGINEERING NEWS of Apr. 27, 1905. Some details of the work then under construction were also given.

The Bow Valley Irrigation Block has a total area of 4840 sq.miles, or more than three million acres. Roughly speaking, this is divided into three equal sections known as the western, central and eastern. Owing to topographical conditions, less than one-fourth of the total block can be irrigated. In the western section 360,000 acres are already under ditch, the works consisting of timber headworks diverting water from the Bow River at a point near Calgary and a total of 1600 miles of canals. Of this mileage, 17 is main canal, 254 secondary canals and 1329 are distributing ditches. The latter do not include the small farmers' ditches. More than 10,000,000 cu.yd. of material was excavated on the western section at an average cost of 17½c. per yard.

The central section may be passed over with the mere statement that it contains slightly over 900,000 acres, of which it was first proposed to irrigate about one-quarter. It is not expected now that any portion of it will be put under ditch.

The eastern section of the block contains 1,156,220 acres, of which 440,000 are to be irrigated, thus making in the three sections a total of 800,000 acres which it is proposed to put under water.

Before going further, it may be said that the drainage area of the Bow River at Calgary is about 3800 sq.miles and above the dam at Bassano about 5100 sq.miles. The scanty records of stream flow show a range of from 1000 cu.ft. per sec. to 100,000 or more at Bassano, the high stages being between June 1 and Aug. 15.

As already stated, the irrigation works for the western section have been completed and are in operation. On the eastern section, the concrete portion of the dam, including the head gates, is well toward completion, and about 50% of the material has been placed in the earth dam. Canal construction is well started, but only a relatively small percentage of the total canal yardage has yet been moved.

The earth portion of the Horse Shoe Bend Dam, as the structure at Bassano is called, is about 7000 ft. long. The maximum height of the embankment will be 45 ft.; the top width, 32 ft., and the maximum width at the base, 310 ft. The wet slope is 4 to 1, and the dry slope is 3 to 1. The total volume (1,000,000 cu.yd. of earth) is being taken from the main canal on the other side of the river, which begins with a cut some 50 ft. deep, and transported across the river on a double-track timber trestle.

The masonry dam is a hollow reinforced-concrete structure, designed and being built by the Ambursen Hydraulic Construction Co., of Boston and Montreal. The dam has a total length of 720 ft. between abutments and a maximum height of 40 ft. to the overflow crest, but water will be retained to a depth of 11 ft. above the crest by means of 24 structural-steel gates of the Stoney type, each having 27 ft. clear span and supported at the ends by concrete piers. The masonry dam is founded on a thick blanket of very dense blue clay.

It should be added that the spillway is designed to pass 100,000 cu.ft. per sec. The five 20-ft. openings for the head gates which form an integral part of the dam will also be controlled by Stoney gates. These will discharge into the main canal, which will have a bed width of 90 ft., slopes of 1 to 1, a grade of 0.016%, and is designed to discharge 3800 cu.ft. per sec., which classes it with the largest canals of the world. The canal has a summit cut of 55 ft. about 1000 ft. from the head gates.

A notable feature of the eastern section irrigation works not already mentioned will be a storage reservoir with a capacity of 186,000 acre-ft. The reservoir will be about 4½ by 9 miles in area and will be formed by a number of earth dams, the largest of which will be 30 ft. high and 2000 ft. long. This reservoir will be used to store flood water between irrigation seasons.

Perhaps the most unique feature of the irrigation-works heading at the Bassano dam will be a reinforced-concrete flume 10,500 ft. long, with a maximum height of 54 ft. and a sectional area of 129 sq.ft. The section will be in the form of a hydrostatic catenary composed of a reinforced-concrete shell only 5 in. thick suspended from a reinforced-concrete structure. The flume will contain some 25,000 cu.yd. of concrete and more than 2,000,000 lb. of steel. This structure will be located near Brooks, about 35 miles east from Bassono.

The total mileage of the canal and ditch system of the eastern section of the block will be 2500, of which 5 miles will be main canal, 475 miles secondary canals and 2020 miles distributing ditches. The thousands of structures included in the canal system will be composed to a large extent of reinforced concrete. The company will carry water to the boundary of each farm unit of 160 acres or less.

This vast irrigation project, as well as the development and sale of all the farm lands owned by the Canadian Pacific Ry. in the three provinces of Saskatchewan, Alberta and British Columbia, together with the handling of coal mines and forest lands, is under the Department of Natural Resources. The headquarters of the department are at Calgary and Montreal, the main operating offices being at Calgary. J. S. Dennis, assistant to the president, is at the head of the department. A. S. Dawson is chief engineer, with offices at Calgary, and H. B. Muckleston is assistant chief engineer, with offices at Brooks.

Anyone wishing to visit the dam would save time, if passing from east to west, by stopping first at Bassano. A stop in Calgary would enable an engineer to call at the head offices of the department and would also give an opportunity to see the rapidly growing city of Calgary. As outlined in our issue of July 11, 1912, a large amount of interesting municipal public work is now under construction at Calgary, which is by far the largest town on the Canadian Pacific between Winnipeg and Vancouver.

A Lubricator for Elevator Guides which was tried out recently on one of the elevators at the 168th St. station of the New York subway required only 30 oz. of grease for lubrication per month, compared with 480 oz. of grease consumed per month under the old hand method of lubrication. At the same time, it is claimed there was a reduction in the amount of power required to run the elevator. The lubricator used consisted of the grease cup attached to the frame of the car with feed tubes leading from the cup to slot-shaped orifices held against the elevator guides by springs. The cup is so arranged that a small amount of air is trapped below the cover, and by giving the screw top an occasional turn sufficient air pressure is maintained to expel a thin ribbon of grease along each surface of the elevator guide as the car moves up and down. It is stated that in ordinary operation these grease cups have to be filled at intervals of from eight to twelve weeks. The device is known as the Economy elevator guide lubricator, and is manufactured by the Peterson Engineering Co., 50 Church St., New York City.

A Large Concrete Pressure Pipe

By F. W. Hanna*

The U. S. Reclamation Service has probably had more experience than any other organization with the construction of reinforced-concrete pipe lines to carry water under pressure. This article describes the Forest Pipe Line of the Boise Project, a 1¾ mile, 36 in. line under approximately 70 ft. head.

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The Forest reinforced-concrete pipe line diverts water from one of the canals of the Boise Project, U. S. Reclamation Service, and carries it across the natural depression passing through the Deer Flat reservoir immediately below the lower Deer Flat embankment for watering 2800 acres of excellent fruit land lying to the southwest of Caldwell. The pipe has an internal diameter of 36 in., an external diameter of 42 in. and a length of approximately 8575 ft. There is a fall between the water surface at the inlet and that at the outlet of approximately 45 ft., thus giving a carrying capacity of about 50 sec.-ft. on the basis of a value of N in Kutter's formula of 0.013. The maximum hydrostatic head under which the pipe line will be operated is approximately 70 ft., and over 6000 lin.ft. of the line carries a hydrostatic head between 60 and 70 ft.

The pipe line is provided at the inlet end with a weir pool, a weir and a reinforced-concrete inlet structure, and at the outlet end with a reinforced-concrete outlet structure and a weir pool and weir. Throughout the course of the pipe there are installed at practically equal intervals, seven manholes, each consisting of a cast-iron saddle bound by steel reinforcement to the pipe and a cast-iron cover closing the 10x15-in. opening. There are also two blow-off valves and two throttle valves. The throttle valves have for their purpose the controlling of the discharge of the water through the pipe so as to make it act under a full head with any quantity of discharge that may be desired to carry through it and at the same time obviating vacuum troubles in operating the pipe.

The pipe proper consists of tiles, each 6 ft. long and 3 in. thick reinforced with ⅜-in. wire and joined together by means of concrete collars. These collars are 3 in. thick and 8 in. wide at the outside with a batter of ¼ in. radially toward the center of the pipe. Each collar is reinforced circularly with three coils of ⅜-in. wire, stiffened transversely with eight ⅛x¾-in flats bent down radially toward the pipe 1½ in. at the ends to form supports on the pipe for the coils.

The Plant

The plant used in the construction of the pipe consisted principally of a sand and gravel plant, a concrete plant, a reinforcing steel coil plant, tile forms and collar forms. The design of the reinforcing coil forms for the tiles and of the tile forms were similar to those used on the Umatilla Project, Oregon, in the manufacture of the pressure pipes described in ENGINEERING NEWS, Feb. 16, 1911, p. 208.

GRAVEL PLANT—The gravel plant was located in a borrow pit that had been excavated in the construction of the dam, and consisted of an elevated trap equipped with a 1-in. coal screen for rejecting stones of excess size, and a ¼-in. sand screen for separating the useful gravel and sand. The trap and screens were so arranged that the waste gravel was deposited by gravity in one dump car, the useful gravel in another and the sand in a third.

CONCRETE PLANT—At a point about 2000 ft. from the gravel pit the concrete plant was constructed. This plant consisted of a chute from the top of an embankment provided with a swinging gate for guiding the gravel and the sand into their respective storage bins, a storage bin each for the sand and the gravel, a mixing platform at the base of the gravel and sand bins, gates arranged for drawing out the sand and the gravel by gravity in the proper proportions for use in the mixer, a ½-cu.yd. mixer operated with a 12-hp. gasoline engine beneath the sand and gravel bins so that the aggregates could be dropped into it by gravity from the mixing platform at such an elevation as to permit of discharging the concrete by gravity from it into the dump cart used in transporting the concrete to the pipe yard.

REINFORCEMENT PLANT—Adjacent to the tile yard, located but a short distance from the concrete plant, was constructed an open shed (Fig. 2) under which the men worked in manufacturing the steel coils for reinforcing the tiles and collars. The plant for manufacturing the coils for the tiles consisted of two steel drums of the proper dimensions for giving the desired shape to the coils. Each of the drums consisted, essentially, of an axle supported in a horizontal position on which was placed two wheels spaced 36 in. apart from outside to outside, one having a diameter of 36 in. and the other a diameter of 35⅞ in. Riveted to these wheels at their circumferences at intervals of $\frac{1}{10}$ of their circumferences and running approximately parallel with their common axle were 1¼x1¼x⅛-in. angles to form a resting base for the coils. In order to secure the proper spacings of the wire and the coils, spacer bars, with notches ⅜ in. in depth at proper intervals, were attached to the wheels at every fifth angle bar by means of small butt hinges that permitted of the bars being turned down out of the way when removing the coils. The spacer bars were 1½ in. wide, so the tops of the bars projected beyond the angle bars ¼ in., thus providing a means

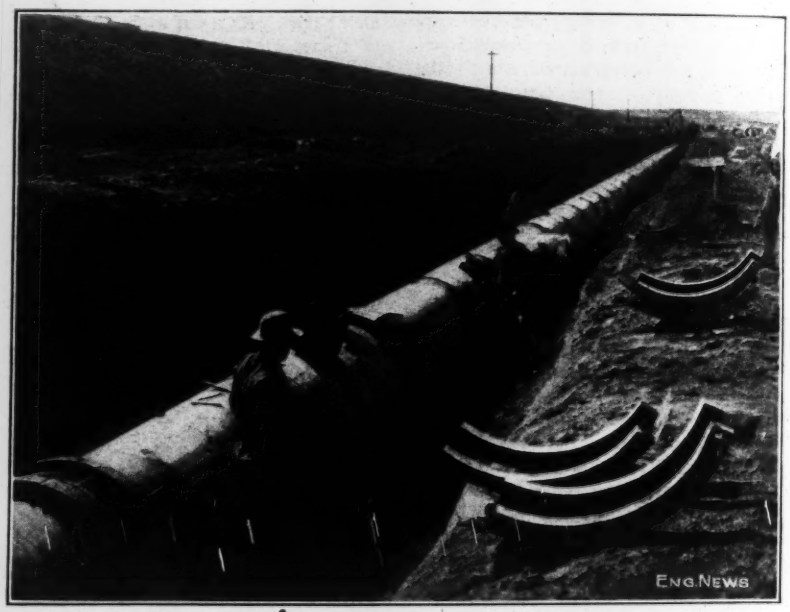


FIG. 1. FOREST PIPE LINE IN THE TRENCH. COLLAR FORMS IN PLACE

of holding the coils rigidly in place during their manufacture and so the bottoms of the notches projected $\frac{1}{8}$ in. beyond the angle bars, thus permitting the coils to be readily removed.

The form for shaping the reinforcing coils for the collars consisted essentially of a wooden drum, 39 in. in diameter and 8 in. long. Eight spacer bars, provided with the requisite notches for holding the reinforcing wire in place were hinged at equal intervals to the drum in recesses on its surface parallel to its axis. These spacer bars projected beyond the cylindrical surface when turned up and lay down into the recesses when turned down. Intermediate between the spacer bars were made in the surface of the drum for its full length, notches or recesses of about 2 in. width and 2 in. depth for permitting the easy attachment of the longitudinal reinforcing and support bars.

Tile Forms—The forms used in molding the tile (Fig. 3) consisted each of an inner steel cylinder for giving the inner surface to the concrete tile, an outer steel cylinder for giving the outer surface to the tile, a base ring and a top ring. The outside diameter of the inner cylinder was 36 in. and its height 6 ft. The cylindrical surface was composed of three longitudinal sections, two large ones and one small one of about 1 ft. arc, each hinged together by removable rods that held the segments rigidly in place. By removing one of the rods that joined the smaller section to one of the larger section, the small section could be revolved inward and thus permit of the collapsing of the other two sections sufficiently for the removal of the inside form from the tile by means of an A-frame provided with guy ropes and rope pulley blocks. The inside diameter of the outer cylinder was 42 in. and its height was also 6 ft. This cylinder was made up in two sections, each 3 ft. high, each of which was composed of three equal segments. The parts of the outer cylinder were held together by clamping bolts arranged to facilitate rapid removal of the forms, which, owing to the segmental divisions of the outer forms, made them easily removable by hand. The base and top rings were made of cast iron and were so designed as to make the joints, when placed end to end, slightly more open on the inner edge than on the outer, thus permitting easy calking of the joints of the pipe line from the inside.

For removing the tiles from the base rings a gripping device, consisting of two thin galvanized sheet-iron strips about 1 ft. wide and half the length of the circumference of a tile, fitted with blocks at the ends, bolted together for securing compression around the tile, were used. The tiles were lifted from the rings by means of two jack screws working under the blocks. There were forty complete sets of forms used in making the tile with two extra sets of base rings.

Collar Forms—The forms for the collars (Fig. 1) consisted of 3x3-in. red-fir sticks sawed on the inside to the outside radius of the pipe and on the outside to a radius 3 in. greater than that of the outside radius of the pipe. The side surfaces of the timbers were battered outward ¼ in., so as to facilitate the removal of the forms from the concrete. The entire form consisted of four segments of equal lengths, each composed of a pair of the circular timbers above described, spaced 8 in. apart at the outside with pieces of galvanized sheet iron nailed onto the outside of them for the full length of two of the four segments and for a little over one-half the length of the remaining two so that there was an open space at the top equal to a little less than one-fourth of the circumference of the pipe. The segments of the collar forms were fastened together by means of U-shaped dowels that were lightly driven into holes near the ends of the timbers.

Fig. 2. Reinforcement Fabrication

Concrete Materials

The sand and gravel for the concrete were obtained from a natural river deposit located at the sand and gravel plant already described. Both the sand and the gravel graded well and were of an excellent quality of granitic materials. The cement used was a brand manufactured at Devil's Slide, Utah. The concrete was mixed in proportions, by volume, of 1:2¼:3, cement, sand and gravel, with sufficient water to give the mixture a wet consistency. These proportions made an excellent, dense concrete, well adapted to the manufacture of pipe for high water pressure. In purchasing the steel, mild steel was specified, but it was necessary to accept soft steel for the wire coils to avoid the necessity of waiting for the mild steel to be rolled especially for the job. A working stress of 10,000 lb. per sq.in. was used for the circular reinforcement, except for a limited stretch of the pipe, where 1¾-in. spacing gave stresses ranging between 10,000 and 12,000 lb. per sq.in.

Construction

Field work was begun on assembling the plant for construction of the pipe line during the month of June, 1911, and the work was completed in November of the same year, with the exception of a portion of the backfilling. In addition to the design and purchase of forms and materials and the construction of the sand and gravel and concrete plants, the work consisted of the manufacturing of the steel coils for reinforcing the tiles and collars, the manufacturing of the tiles, the digging of the pipe trench, the loading and hauling of the tiles from the tile yard to the trench, the laying of the tiles in the trench, the calking of the joints of the pipe, the construction of reinforced-concrete collars on it and the backfilling of the pipe. All of the work was done by government forces, including the preparatory work of constructing the sand and gravel and concrete plants, with the exception of the excavation of a portion of the pipe trench.

Coil Manufacture—In making a steel reinforcing coil, the wire was supported on a reel arranged to shift laterally in

front of the drum and was attached to the drum at one end. The wire was then passed completely around the drum so as to lap a distance of about 1½ ft., and the lapped portions were securely wired together. The wire was then started on

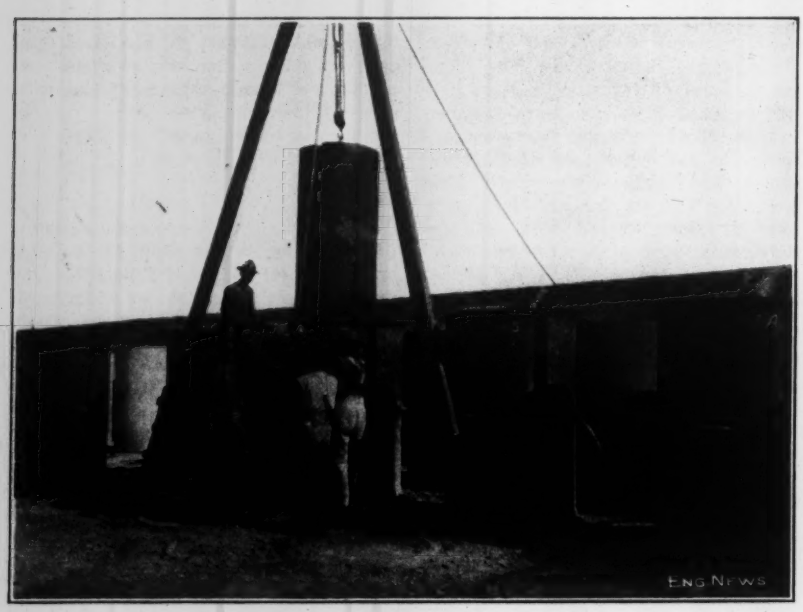


FIG. 3. FORMS FOR CONCRETE TILE

and continued in its spiral course around the drum until it reached the other end, where it terminated in a similar right sectional coil about the drum. Eight longitudinal bars to the coil were then used at equal spacings around the coil and the flattened ends of these bars were turned down over the end wires of the coils and the whole coil was then securely bound together by means of No. 16 gage black-iron wire.

TILE MANUFACTURE — The aggregate for the concrete was excavated from the gravel pit with teams and dumped into the trap onto the screens from where it descended into the dump cars. The loaded dump cars were hauled from the sand and gravel plant to the concrete plant at odd times with locomotives used in the work of facing the lower Deer Flat embankment with gravel, which work was in progress simultaneously with the construction of the Forest pipe line. The concrete was hauled from the mixing plant to the pipe yard in a ⅔-cu.yd., one-horse concrete dump cart. Preparatory to filling the forms, the base rings were carefully set, the forms were oiled with crude oil and set onto the base rings and the lower reinforcing-steel coils were placed in the forms. The concrete was then shoveled into the forms and thoroughly worked adjacent to the forms to insure good surfaces and high density. The number of tiles that could be made in a single day was limited by the number of forms available. In the cooler weather it was found practicable to make only 20 tiles per day with the 40 forms, while in the warmer weather it was possible to make as high as 33 tiles per day with them, with an average of about 30. The tiles were allowed to stand on the base rings, usually, 48 hours and they were sprinkled during the sunshine hours continuously for the first 10 days after they were made.

TRENCHING—The pipe trench was dug with a bottom width of 5 ft., a depth of approximately 5 ft. and side slopes of 1 to 1. About 2000 lin.ft. of the trench were very wet and this portion was consequently expensive to excavate. In order to drain the wet area and to protect the pipe from possible injurious effects from alkali and also to assist in drying out the trench during its excavation, a drainage ditch was dug 1 ft. deeper than the pipe trench for a distance of about 4000 ft. The excavation of the trench and the drainage ditch was begun in the latter part of August and was completed during the forepart of October, 1911.

CONVEYING TILES—One of the interesting features of the work was the loading, hauling and unloading of the tiles. The tiles were upset in the tile yard and rolled into position under an A-frame equipped with guy ropes, to which was attached a 2-ton chain block for lifting the tiles. As a means of attaching the chain block to the tiles, two log chains of proper length to reach around a tile and over the ends of a 6x6-in. timber, 4 ft. long, were cut and fastened to the ends of such a timber. At the midpoint of the timber an eye-bolt was inserted to provide an attachment for the grab-hook of the chain block. By means of the chain block two men readily hoisted a tile to sufficient elevation to permit of backing a wagon under it. For hauling the tiles, wagons without boxes were used and to form rests for the tiles, two 6x6-in. timbers, 12 ft. long, were laid on the bolsters adjacent to the standards of each wagon. Notches were cut into these timbers at the points where the chains used in hoisting the tiles would come in placing them on the wagons.

FIG. 4. LOWERING A TILE INTO POSITION, FOREST PIPE LINE, BOISE PROJECT, U. S. RECLAMATION SERVICE

The tiles were lowered onto the timbers with their axes parallel with the timbers. Two tiles were hauled at a load, thus making a good two-horse load of approximately 2½ tons. An A-frame with guy ropes and a chain block were used for unloading the tiles at the trench. In handling the 1429 tiles required for building the pipe only one was dropped and injured.

Fig. 4 illustrates the method of placing the tiles in the trench. The bed of the trench was excavated carefully to a uniform grade, and, to form solid supports for each tile, there were generally placed in the bottom of the trench two 2x12x18-in. pieces of plank so spaced as not to interfere with the placing of the collars. In the wet portion of the trench larger pieces were used for foundations. The reinforcing coils for the collars were slipped over the end of each tile before the succeeding tile was lowered into place. A pair of wedges made of 4x4-in. timbers, 16 in. long, were then driven under the tile on top of each of the 2x12x18-in. planks to raise the tile to grade, after which it was forced home. A distance of 162 ft. could be made in an eight-hour day from one end of the pipe.

CALKING TILES—Stress was laid on the importance of thoroughly calking the joints from the inside. The calking was done with a mixture of one part cement to two parts sand tempered with hydrated lime to the extent of about 10% of the volume of cement. As soon as the inside calking had set, a party followed with the collars. It might be stated here that before placing the tiles in the trench the ends were carefully brushed with a wire brush, as were the outer surfaces of the tiles for a distance of about 4 in. back from the ends thereof and the surfaces were lightly picked over with a small pick so as to form a good surface for adhesion of the collars. The concrete for the collars was mixed wet and was poured into the collar forms at the opening at the top and was worked with a circularly formed rod so as to give smooth surfaces to the collars and so as to obviate the formation of voids in the concrete. A mixture of one part cement and three parts of sand and gravel passed through a ⅝-in. mesh screen was used in the collars. This process gave excellent appearing and evidently very satisfactory collars as judged from the results. All of the high-pressure tiles were whitewashed on the inside with a cement wash once during their period of curing, and the calking at the points on the inside of the pipe was kept moist for several days by a similar process of whitewashing. As soon as the concrete in the collars had set sufficiently the pipe was backfilled to one-half the depth of the pipe and the tops of the collars were covered with wet earth. Prior to this covering all of the collars were thoroughly sprinkled during their period of setting.

TESTING THE PIPE

Owing to the fact that water was not available for testing the pipe line during the fall of 1911, the backfilling was not completed, except to about 1 ft. over the top of the pipe, so as to prevent excessive contraction during the winter weather and consequent cracking. On Apr. 8, 1912, water was turned into the pipe for the first time until it was about half full, and on Apr. 9 the pipe was completely filled. There were at this time noticeable a number of minute leaks. A small discharge of water, however, was run through the pipe continuously and with it some two or three loads of sawdust. The leaks in the pipe improved very rapidly until within the course of a month all of them had practically ceased. The appearances now are that the pipe will go into final service without turning the water out and without any requirement whatever of patching or calking leaks. The success of the pipe is attributed to the excellent proportioning of the aggregates in the concrete, the use of a very wet mixture of concrete, assiduous spading of the concrete in the forms, the continuously wetting of the tiles for 10 days, extreme fidelity in calking the joints, excellency in the design of collars, the laying of the pipe in cool weather and general care in the execution of the work in all of its details.

COST DATA

In the subjoined table is given a complete final cost analysis of the Forest pipe line. The unit cost of $4.50 per lin.ft. of pipe includes all overhead charges of whatsoever nature from field supervision and from the operation of all offices of the Reclamation Service.

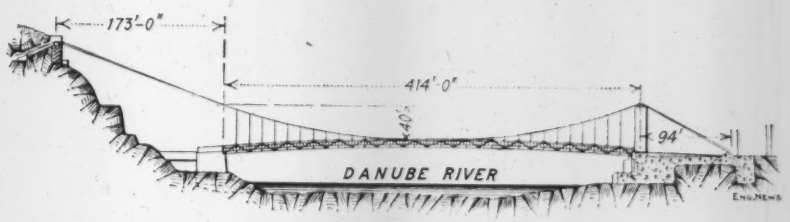
	Subdivision	Unit Cost
1.	Tiles, concrete	$1.128
2.	Tiles, reinforcement	0.852
3.	Collars	0.380
4.	Installation of tiles	1.157
5.	Structures	0.309
6.	Plant depreciation	0.320
7.	General expense	0.353
		$4.500

BOISE PROJECT

The Boise Project lies in the Boise and Snake River Valleys near Boise, in the southwestern part of Idaho. The project originally involved the construction of a diversion dam and a complete distribution system for 160,000 acres of land, the Deer Flat Reservoir and the Arrowrock Reservoir for furnishing stored water to these lands and to about 79,000 acres of other lands in the Boise Valley. All of the work, except Arrowrock reservoir, is practically completed. The Forest pipe line is a part of the distribution system referred to, and the principal officers connected with its construction are F. E. Weymouth, Supervising Engineer of the Idaho Division; Walter Ward, Division Engineer; G. G. Hughes, General Foreman, and the writer, Project Engineer.

A Novel Suspension Bridge Across the Danube

A recent number of *Deutsche Bauzeitung* describes the suspension bridge which is shown in the accompanying figure. The bridge, which has been recently completed, supplants an older highway suspension bridge which crossed the Danube River near Passau, a city on the frontier of Austria and Bavaria. The novel feature of the bridge, as will be noticed, is the anchorage of one end of the cable to the high rock bluff on the side of the river, thus dispensing with the use of the usual tower over the supporting pier at that end.



A SUSPENSION BRIDGE WITH ONLY ONE SUPPORTING TOWER

The stiffening truss is a lattice girder carrying a 21-ft. roadway, 12½ ft. of which is devoted to the highway and the remainder to the sidewalk. The bridge cost about 300,000 marks ($75,000).

The Water Supply of Port Arthur, Ont., has been investigated by T. A. Murray, M. Can. Soc. C. E., of Toronto, Ont., and the city has been advised to abandon a proposed scheme for a gravity supply from Lake Simcoe, and continue to use water pumped from Lake Superior. The problem at Port Arthur is similar to that at Toronto and other Lake cities. With the increase of the city's population and sewage discharge the lake water is becoming contaminated, and some form of purification is necessary. The objections to the use of water from inland reservoirs is stated in this case to be the difficulty in removing a brown vegetable coloring matter, due to the bogs on the watersheds. Mr. Murray has concluded that the clarifying of this water would cost more than to treat the Lake water with hypochlorite of lime or subject it to slow sand filtration.

Natural Gas in Hungary: A Remarkable Eruption near a Gas Well*

By A. Strobl†

It has been known for a long time that natural gas exists in Hungary. Records dating back to the 17th century mention "burning wells" near Bázno, a small village in Transylvania, and more recently natural-gas wells delivering 280 to 350 cu.ft. per hour have been found in drilling for artesian wells in the Great Hungarian Flatland. The present development of the Hungarian gas fields, however, resulted from an extensive exploration conducted by the Hungarian government in the hope of finding deposits of potassium salts.

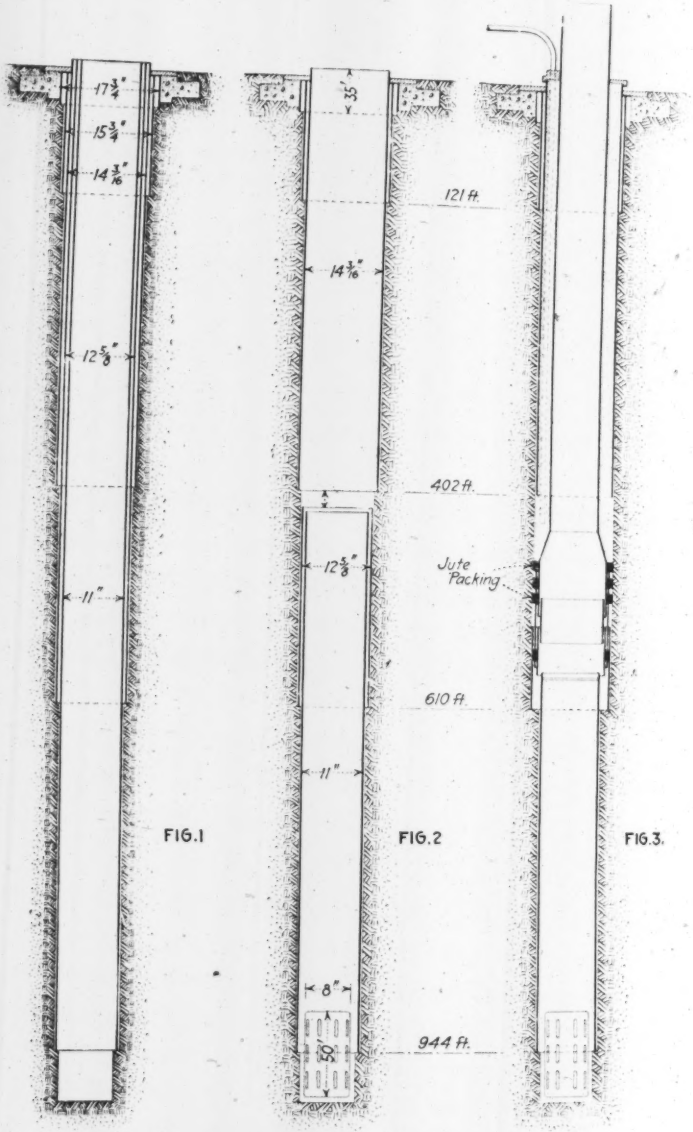
A drill hole, started Nov. 26, 1908, near the village of Kis Sármás, struck natural gas at small depths, the quantity increasing with the depth of the well. At a depth of 991 ft. the gas escaped under such pressure as to compel suspension of the drilling. Thus, while no potassium salts had been found, an exceedingly rich natural-gas region was discovered.

The Hungarian government, in order to prevent the economic losses which would be the result of private exploitation of the natural gas, and to insure the necessary subsequent explorations, presented a bill to the parliament, in which it was proposed to make a state monopoly of oil, gas and salts of potassium. The bill passed the legislature in October, 1910, although it was opposed by landowners, and the government ordered the immediate exploration of the whole Transylvanian valley.

The geologists thought that, as in the gas and oil fields of America, the gas would rise to the axes of the anticlines, the oil being found on their flanks and the salt water in the synclines. The result of the researches was that more than 20 anticlines were discovered on an area of 60 by 100 miles running in a direction approximately north and south. The gas well at Kis Sármás is also situated on the axis of an anticline. The work is proceeding with dispatch, 10 holes now being drilled at Kis Sármás and several others are planned. The budget of the Minister of Finances provides 2,700,000 crowns (about $540,000) to be expended for drilling during the fiscal year.

At the drilling of the well at Kis Sármás, which commenced Nov. 26, 1908, traces of gas were found at a depth of 72 ft. After that several gas strata were struck. The sands at a depth of 374, 525, 629, 680 and from 746 to 990 ft. furnished continually greater quantities of gas. At a depth of 374 ft. so much gas appeared that the petroleum lamp in the drilling derrick ignited it and caused an explosion. It took 10 hours to extinguish the flames.

The gas coming from a depth of 525 ft. threw the water column from the hole to a height of 65 ft. After reaching the 629-ft. level, the well was shut off for a short period, and the manometer registered 60 lb., although the closing of the well was imperfect. The pressure of the gas coming from a depth of 680 ft. was found to be 270 lb., the quantity being 134,178 cu.ft. per hour. The strata 746 to 990 ft. down developed a pressure of 420 lb., and the amount of gas delivered by the well increased to 1,270,000 cu.ft. per hour, that is, 30,480,000 cu.ft. per day. The average velocity of flow was 620 ft. per second. The tremendous force of the gas made it impossible to continue the boring. This well was finished on April 22, 1909. For a long time there was a free escape of gas which could be heard several miles away.



FIGS. 1, 2 AND 3. SECTIONAL DIAGRAMS, SHOWING LINING AND PACKING OF GAS WELL AT KIS SARMAS, HUNGARY

(The horizontal scale is about 61 times the vertical scale.)

Professor Pfeifer's tests show that the gas contains 99.6% methane (CH_4), which makes it an ideal fuel. Its heating power is 960 B.t.u. per cu.ft. The amount of gas furnished by the well at Kis Sármás represents about 60,000 hp. per day when used to raise steam for steam engines, and far more when used in gas engines.

In order to prevent the large waste of

*From an article in the July "Journal" of the Society of Hungarian Engineers and Architects of America.

†Chemical Engineer with Toch Bros., 320 Fifth Ave., New York.

gas until such time as it could be used for industrial purposes, a method of closing up the well had to be devised. It was hoped that the problem might be solved by setting a valve on the top of the casing. This hope was based on the belief that the clay beds drilled through in boring were closely pressed against the outside of the casing and therefore would not permit the escape of the gas on the outside. This expectation seemed to be justified, moreover, by the fact that in America the closing of many high-pressure wells has been successfully carried out in this manner.

The closing head consisted of a heavy iron valve weighing several hundred pounds. The first closing experiment was made June 22, 1910, the well remaining closed from 5.30 a.m. to 7.30 p.m., during which time the pressure rose progressively to 405 lb. This pressure remained constant for one hour, after which the valves were opened. They were closed again the next day at 6 a.m. and remained so until June 24, at 2 p.m.

As early as the morning of June 23, it was observed the gas was escaping some 100 ft. away from the well, in a ring about 50 ft. wide. The escape of gas increased during the day and in the evening rumblings could be heard in sections of the earth where the gas had not previously escaped. The eruption of the gases grew so strong on the same day at 11 p.m., that the pressure in the well decreased to 75 lb., while the gas emitted through the earth blew the ground water up like springs to a height of 6 ft.

Several other closing trials were made in succession, and it was ascertained that the escape of the gas through the earth was growing in strength. The natural explanation was that the gas found a way between the casing and the hole into the porous soil and came to the surface. It became evident that there was no other way available except by packing the outside of the casing.

The work of packing was started on May 19, 1911, and was carried out by Thumann, a drilling contractor, of Hale (Germany). It was a great handicap in designing the packing that the pipes were strongly pressed against the hole, and therefore the location of the packing could not be chosen; it was determined in advance by the conditions.

The pipes were of relatively large diameters, as they were intended originally to pass salts of potassium and not for natural gas. The hole, as shown in Fig. 1, was lined with five sizes of casing, as follows:

17¾	in.	diam.	to	the	depth	of 35 ft.
15¾	in.	"	"	"	"	" 121 ft.
14⅞	in.	"	"	"	"	" 402 ft.
12⅝	in.	"	"	"	"	" 610 ft.
11	in.	"	"	"	"	" 944 ft.

The last 46 ft. of the hole was not cased.

The gas could be prevented from escaping up the circumference of the drilling by tightening the hole. By this means it would be possible to collect the gas coming from the deepest and richest sand into the innermost pipe, while the gases of the higher strata would rise separately into the space between the respective pipes. But after taking off the closing head and trying to lift the pipes it was discovered that all were so strongly wedged in place that it was impossible to pull them out and they could not be packed for this reason.

After several trials, it was found that the only free section was a pipe 32 ft. long, a part of the 12⅝-in. casing, situated below the end of the 14⅞-in. pipe at a depth of 402 ft. Under such circumstances it seemed evident that this was the only place where a packer could be applied, as the packing of the other pipes was out of the question. The location of the packer would have been selected in any event above the sand at 525 ft., which is furnishing a great quantity of gas, there being no hope of saving the gas coming from the 374-ft. sand.

The records of the boring showed a bed of hard clay at a depth of 400 to 416 ft., and this depth was selected for the packing. In order to prevent the slipping of earth in the last unprotected section, a perforated pipe 50 ft. long and 8 in. in diameter was lowered to the bottom of the well. Then the 11-in. pipe was cut at a depth of 421 ft. (Fig. 2) and it was pulled out of the hole. Next, the 12⅝-in. pipe was cut at 418 ft. and lifted. Consequently the hole between the depths of 402 to 418 ft. was deprived of its casing, and the packer was placed here, as shown in Fig. 3.

The packer is mounted on a pipe of 8 in. diameter and consists of four jute cylinders, of which the three upper ones tighten the space between the packer pipe and the hole, and the fourth tightens the space between the packer pipe and the 12⅝-in. pipe. Into the space between the 8-in. and 14⅞-in. pipes cement mortar was pumped, thus completely filling the space between the two pipes and also that between the 8-in. pipe and the circumferential wall of the hole. The spaces between the other pipes of greater diameter were also filled with cement.

Fig. 4 shows a perspective view of the closing head and Fig. 5 a section of the same, showing the method of anchoring. After the cement became hard the valve head was again mounted, the valves closed and consequently the pressure of the gas reached progressively 420 lb. It has been constant since that time. The work of tightening was finished on July 30, 1911.

Opinions differ widely concerning the correctness of this method of packing. On Oct. 29, 1911, there was a sudden eruption, like an earthquake, in the vicinity of the gas well. The gas burst out with great force at a distance of about 1400 ft. from the well, and within a radius of 1000 ft. it threw the earth to a great distance. From the craters escaped an immense quantity of gas, estimated later at several millions of cubic feet. This was ignited by a lamp burning in a near-by house and burned with an immense flame. It was difficult to extinguish the fire, and its quenching was accomplished only by throwing wet earth into the fissures in such a manner as to prevent the escape of more gas. No change could be noticed in the condition of the gas well. The pressure remained constant at 420 lb.

Naturally, the question arose whether there was any relation between the eruption and the well and became the subject of a lively discussion among experts.

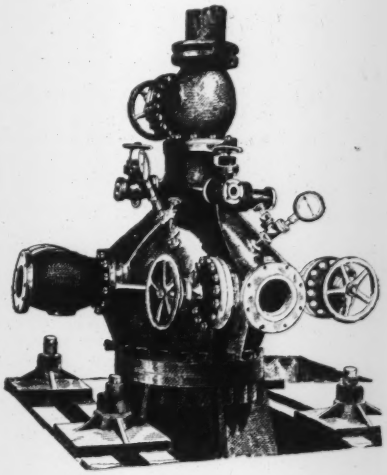


FIG. 4

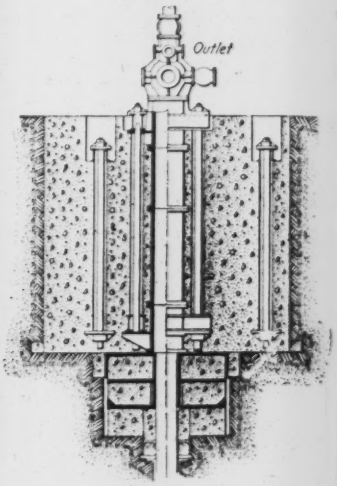


FIG. 5

FIGS. 4 AND 5. THE CLOSING HEAD FOR THE KIS SARMAS GAS WELL
(Fig. 5 shows a sectional view of the anchorage.)

It is not settled yet. There are two widely different opinions. One party, including Mr. Böhm, the resident engineer in charge of the borings, contends that the eruption was entirely independent of the well and that its cause was purely tectonic. Prof. Cholnoky, Prof. Pfeifer and others assert that the faulty packing of the well was directly responsible for the outburst.

Mr. Böhm urges the tectonic theory, stating that the well has shown a constant pressure of 420 lb. after the explosion, which would not have been the case if there had been any relation between the well and the eruption. Before and after the eruption, shakings were felt in the vicinity and the groundwater rose above the soil level, which phenomena usually attend earthquakes.

Messrs. J. Wodetsky and A. Körösi made calculations and taking into consideration the dimensions of the craters, they figured out the quantity of the earth masses which were thrown out and came to the conclusion that for the extent of the eruption, a pressure of from 500 to 900 lb. was necessary to produce so great an effect. The pressure in the well never having exceeded 420 lb., they are of the opinion that the eruption was the result of tectonic changes.

Messrs. Cholnoky and Pfeifer maintain that the eruption was caused by the insufficient packing of the well. The packer is at a depth of 416 ft., and it shuts off only the higher conducting regions. The gases coming from the deepest and richest layers are not shut off, and they transfuse into the next conducting layer, above which there is a layer of clay. All the layers rise toward the surface. The transfusion was slow on account of the frictional resistance, but at last the pressure grew so strong in the upper conducting region that its force blew up the covering clay layer at a point where it rose nearest the surface.

For proof of the existing diffusion, they refer to American wells, in which the gas reaches its maximum pressure within a few minutes after the closing of the valves, while at Kis Sármás the maximum was only reached after 37 days.

Mr. Pfeifer believes that the packer should have been placed, as in all American wells, right above the conducting sands and not 95 ft. higher. He suggests the abandonment of the well and the drilling of another, which would be driven with knowledge of what might be expected, and he wants the work done by an American expert.

After the eruption in October, the well did not show any disorder. Nevertheless time will tell which of the two opinions is correct.

Several projects to utilize the natural gas have been discussed. At first the piping of the gas to Budapest was suggested, involving a pipe line 267 miles long, but this project was abandoned. For the present the government wants to utilize the gas for industrial developments. Among the enterprises to be undertaken in the near future there is one which will directly use the heat of the gas flames to produce nitrate of potassium by a patented method. This factory will use 7,000,000 cu.ft. daily. Another group of interests, backed by the Solvay Co., of Brussels, intends to invest 4,000,000 crowns, and expects to manufacture chloride of lime, etc., by the electrolytic process. There are several other industrial undertakings projected, and it is expected that the towns in the vicinity of the gas region will be supplied from this source also.

The Sherardizing Process for Preserving Iron and Steel*

By Oliver W. Storey†

In the sherardizing process, iron articles are heated in zinc dust, which does not melt, and a coating of zinc-iron alloy is obtained on the surface. The process is the invention of Sherard Cowper-Coles, an Englishman, who is an authority on the various galvanizing processes. His patents were allowed about seven years ago, but it was some years later before the process was introduced commercially into the United States. The patents in this country are controlled by the U. S. Sherardizing Co., of New Castle, Penn.

In the latter part of 1908 the first successful commercial work in this country was turned out by the National Metal Molding Co., of Pittsburgh. The progress of the process was quite slow during the first year, but during 1910 and 1911 it was adopted by a large number of companies, so that it has made tremendous strides during the past two years.

Sherardizing was not entirely unknown previous to the time of Mr. Cowper-Coles' patent, for in 1838, Miles Berry, an Englishman, took out a British patent in which he coated iron and copper in a manner similar to the present process. Various other patents of a similar nature were granted from time to time, but none were of commercial importance. The process of sherardizing may be likened to the process of making blister steel by the cementation process, except that zinc dust is used instead of charcoal. Also, sherardizing is merely a skin effect, as in the case hardening of steel, and does not penetrate the metal to any appreciable extent.

Zinc dust is a byproduct of the smelter, and until a few years ago very little use was found for it. It consists almost entirely of very fine globules of zinc covered with zinc oxide, though there is a certain portion of unoxidized zinc also present. This oxide has a very [illegible] cial effect, for it prevents the melt[illegible] of the zinc in the sherardizing r[illegible]s, should the melting point of zi[illegible] be passed.

This "blue dust" varies somewh[illegible] according to the constitution of the zinc ore used and care used in roasting and condensation of the zinc fume. The best "blue dust" on the market at present is the German dust, as it has 89 to 92% of metallic zinc, while the domestic product usually ranges from 75 to 85%. On the other hand, the domestic material contains less than 1% of lead, while the German always contains above 2%. The effect of the lead on sherardizing has not been determined.

In the following description of sherardizing, I am giving the methods in use at the plant of the company mentioned, which is capable of sherardizing 40 to 50 tons of conduit pipe daily, and is at present the largest plant in the United States and probably in the world. A variety of articles are sherardized, including conduit, metal molding, electrical fittings, couplings, screws, bolts, locknuts, bushings, etc.

The retorts used are a little over 10 ft. long and 26 in. diameter. They are made of boiler plate and can be opened only at one end. The furnace is large enough to hold ten of these retorts and is fired by natural gas. The process is continuous, in that the retorts are fed in at one end of the furnace and removed at the other. In this way all retorts are subjected to similar heat conditions in passing through the furnace and a uniform coating can be obtained.

While in the furnace the retorts revolve at the rate of one revolution every four minutes. Revolving the retorts insures uniform and quicker heating of the material in the retort, a uniform dust, and a continuous coating. The furnace is usually kept at a temperature of about 750° to 850° F. This temperature varies with the richness of the dust, amount of bulk in the retort, and the length of time the retorts remain in the furnace. With the zinc dust containing 40% metallic zinc, and with the retort filled with ½-in. conduit and the necessary amount of dust, the usual length of time required to sherardize the conduit to the proper thickness is about six hours at 800° F. The temperature of the furnace is controlled by means of pyrometers placed at various points while pressure gages are placed on all burners. This gives absolute control over the furnace, and by going over the records the source of any trouble can be immediately found.

There has been a great deal of discussion as to the proper percentage of metallic zinc in the zinc dust. Many plants are using a 20% dust with excellent results, but owing to peculiar conditions we are using 40% dust. With a low percentage there is more trouble, owing

*Abstract of a paper in the April number of the "Wisconsin Engineer," University of Wisconsin, Madison, Wis.

†National Metal Molding Co., Pittsburgh, Penn.

to the dust clinging to the pipe, while the richer the dust the more delicate the temperature control has to be to obtain a coating that will be of the correct weight. A balance has to obtain between these two factors to obtain the best results.

The surface need not be prepared as carefully as in hot and cold galvanizing. All scale and dirt must be removed, but it is not necessary to remove the lighter oils, though oil would be fatal to the cold galvanizing process. On the contrary, a light oil on a clean iron surface will result in a very bright coat of sherardizing. It is the aim to obtain as smooth and bright a surface as possible before sherardizing, as the zinc dust clings to a rough surface. A piece of cold-rolled steel or any polished surface will sherardize to a brilliant white crystalline coating, while a piece of rough or porous iron or steel will usually become a gray color to which the dust adheres more or less tenaciously.

As zinc in this finely divided condition is oxidized easily, it would appear that the retorts would have to be completely filled and also air tight to prevent oxidation. But in practice the retorts are seldom more than half filled with zinc dust. There is some oxidation, but the other advantages gained more than offset this loss. By using a small amount of dust the retorts can be brought up to a sherardizing heat quickly, cooled quickly and are also very much easier to handle, owing to the small bulk of zinc.

We find that all interior surfaces of retorts are sherardized to a depth of 1/32 to 1/16 in., but this coating does not become any thicker. Retorts having been in daily use for over two years have not shown any signs of appreciable deterioration from that source. Probably the continual pounding and grinding on this sherardized surface has the effect of hardening it and preventing further action.

All material sherardized is tested according to the standard Preece copper sulphate test. Samples of ½- and ¼-in. pipe are taken from various retorts in any one heat and the middle and both ends of each pipe are tested. This pipe must stand four dips in the copper sulphate solution or it is rejected and is re-sherardized. This insures an ample and evenly distributed coating on all material. A heavier coating is not only undesirable owing to the increased amount of zinc used, but also because it will flake when bent. Most specifications call for a coating that stands at least four dips in copper sulphate and does not flake when bent to a certain arc.

Every part of the surface is coated with the protective layer. This makes this process very valuable in the treatment of screw threads, as fine threads and finished machined articles can be treated. The government is specifying sherardized bolts and nuts and various other material for the Panama Canal. Some of these articles will have to stand 10 dips in copper sulphate owing to the severe weathering conditions. To treat screw threads successfully and obtain a 10-dip coating with the older processes would have been an impossibility. With this process the coating is under control so that a 20-dip coating is as easy to obtain as a 1-dip coating. Probably the latest and a very important use to which sherardizing has been put is in the protection of expanded metal lath. After a great deal of experimental work sherardizing was found to be as durable as any protective coating and also cheaper to apply. Another desirable effect for most work obtained with sherardizing is the annealing action of slow cooling in the retorts, which prevents any chilling strains that are likely to be developed as in hot galvanizing.

Inaudible Sound Waves for Ship Signals are proposed by Sir Hiram Maxim. As described in the "Engineering Supplement of the London Times," Mr. Maxim's device consists of a modified form of siren, using high-pressure steam, which is designed to produce powerful air waves having a frequency of 14 or 15 vibrations per second. These waves, while of too low a frequency to be perceptible to the human ear, are intended to have a great penetrating power due to their relatively great amplitude and wave length, so that they can travel over great distances.

The operation of the device depends on the reflection or echo of these waves from any obstacle, such as another ship, an iceberg or a cliff. A receiver is provided for detecting the return of these echoes, which is described in the "Times" as follows:

The receiver may be regarded as an artificial ear. It consists of a diaphragm of rubbered silk, 4 ft. or so in diameter, stretched tightly over a drum-shaped cylinder, and it is so arranged that the air-pressure is always the same on both sides of it, irrespective of the blasts from the siren. The vibrations set up in this diaphragm by the air-waves impinging on it are caused to close a series of electrical circuits, each containing an electric bell of different pitch. Feeble waves, such as would be reflected from a small object or one at a great distance, would cause only slight vibrations of the diaphragm, and thus would close only the first electric contact, thereby ringing the first or smallest bell; larger ones would close the second contact and ring a larger bell, and so on.

The recorder which forms the third part of the apparatus also depends on the action of a diaphragm, but is arranged to give a written diagram of the disturbances in the air. A small light rod is attached to the centre of the diaphragm and passes to the rear, carrying a pencil point that records the vibrations on a moving strip of paper such as is used in a Morse telegraph recorder. When the operator opens the steam valve of the siren he at the same time closes an electric circuit which releases the mechanism of the Morse instrument and allows about 14 in. of the paper to be fed out. When there is no noise except that due to the action of the ship or the sea waves, a regular sinuous line is produced on the paper, but when the vibrations caused by the siren strike an object and return the travel of the pencil becomes greater and the amplitude of the sinuosities is increased. Since the moment when the vibrator is set in action is recorded on the paper, and since the paper moves at a known rate, the interval between the first markings and those produced by the return of the vibrations enables the distance of the reflecting object to be ascertained, while its size may be estimated from the amplitude of the waves recorded.

The siren or vibrator would be mounted on deck, and when the presence of other ships or icebergs, or of land, was suspected at night or in a fog it would be turned to various positions port and starboard, so as to explore the area lying more or less directly in front of the ship. It could also be used to communicate with other ships fitted with receiving apparatus, by means of long and short blasts representing the dashes and dots of the Morse code. To prevent the receivers from being affected by the vibration of the ship, they would be placed within a large hoop suspended by rubber straps.

The "Times" states that this apparatus is as yet in the experimental stage.

A Machine for Testing Lubricants has been recently placed on the market which is distinguished from other oil testing machines in not having a journal bearing for the testing surface. The lubricant to be tested is admitted between the abutting edges of two vertical cylindrical pieces with walls of considerable thickness in proportion to their length. Thus the test is made between two annular surfaces. The speed of the machine can be varied to produce the equivalent of from 50 to 3000 r.p.m., giving a speed of the frictional surfaces of from 5 in. to 25 ft. per sec. Pressure is applied to the lubricated surfaces by means of a lever acting upon the vertical spindle of the upper angular piece. Force is applied at the long end of the lever by means of a screw and hand wheel with a spring-balance attachment to measure the load. The pressure can be varied in this way from 1 lb. to 750 lb. per sq. in. of lubricated surface. Provision is also made for heating the surfaces by means of a Bunsen burner to a temperature of 450° C., and the revolving parts are inclosed in an insulating jacket so that they can be surrounded if desired by saturated or superheated steam when testing cylinder oils. The dry heat is useful in tests of gas engine oils.

The lower annular member is rotated through bevel-gearing by a power-driven spindle. The upper member is free to turn but carries at the upper end of its vertical spindle a horizontal lever arm held from rotating by a helical spring, one end of which is attached to the lever and the other to the frame of the machine. This lever arm carries at its extremity a pencil which acts on the record paper of the machine. When a test is started the lower rotating member is put in motion and a small part of the torque is transmitted through the lubricant under test to the upper member. This torque, representing the amount of friction, is measured by the extension of the coil spring attached to the lever arm of the upper friction member and is recorded on the paper record strip.

An additional special feature of the apparatus is designed for testing the defects of high-pressure superheated steam or of very high dry temperatures in disintegrating the oils and forming sediment. The cylinder oil to be tested is passed through spirals in an inclosed vessel where it can be subjected to the steam or dry heat. Any sediment formed collects on the spirals which can be subsequently removed from the vessels for close investigation. After passing through the testing spirals, the steam and oil can be blown through a test-tube onto a strip of record paper. It is claimed that the condition of the oil can be judged by the appearance of its trace on the paper.

A detailed illustrated description of the machine was published in "Engineering" (London) in the issue of June 28, 1912. The complete apparatus is being placed on the market by the Stern Sonneborn Oil Co., Ltd., Royal London House, Finsbury Square, London, E. C., under the name of the Sternol oil-testing machine.

New Railway Terminals, Seattle, Wash.

The great developments of the cities and commerce of the Pacific Coast have necessitated extensive and costly railway works in providing the necessary facilities for handling traffic, and in providing also passenger stations of a character suitable to the growing importance of these cities. In recent issues we have described work of this character, and in the present article we describe some of the recent improvements at Seattle. In addition there are auxiliary works made necessary by the changing of grades of the city streets and the avoidance of grade crossings. Besides these, there is a project for an entirely new union station with long connecting lines and approaches in order to free the water front from the railways which now cause such a congestion of traffic in this part of the city. Terminal improvements at other Pacific cities are mentioned also in this article.

The Oregon-Washington Railroad & Navigation Co. (successor to the Oregon & Washington R.R. Co.) began acquiring right-of-way in 1906 for a line from Portland to Seattle (with a branch to Grays Harbor) and for terminal grounds in the cities of Tacoma, Seattle and Grays Harbor. In 1907, having acquired all right-of-way necessary, construction work was begun, first upon the terminals in the cities mentioned. The work was not pushed during the succeeding year on account of the financial depression. In 1909, negotiations were concluded for joint and equal use of the existing Northern Pacific R.R. line between Portland and Tacoma; and a new line between Tacoma and Black River Junction (9 miles from Seattle) was constructed for the joint use of the Oregon-Washington line and the Chicago, Milwaukee & Puget Sound Ry. On Jan. 1, 1910, train service by the Oregon-Washington line was inaugurated between Portland and Seattle, temporary terminal facilities having been provided. As Tacoma and Seattle are the Puget Sound terminals of the Union Pacific and Southern Pacific systems, terminal grounds had been acquired in both cities which were liberal in extent and favorable as to location. The work described below was done under the direction of J. R. Holman, Assistant General Manager (in charge of engineering) of the Oregon-Washington R.R. & Navigation Co.; and information concerning it has been obtained through the courtesy of John D. Isaacs, Consulting Engineer for the Harriman Lines.

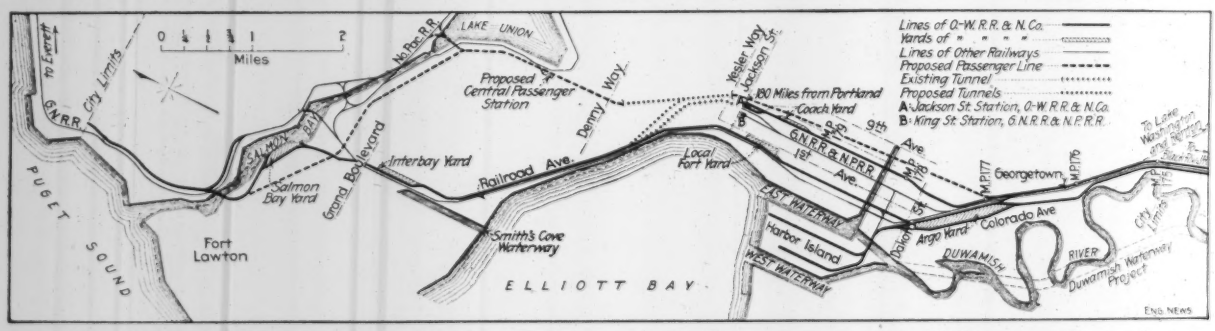


FIG. 1. PLAN SHOWING THE RAILWAY TERMINALS OF THE OREGON-WASHINGTON RAILROAD & NAVIGATION CO. AND OTHER LINES, AT SEATTLE

TERMINALS AT SEATTLE

In Seattle, local freight yards and grounds were obtained in the heart of the wholesale district, necessitating the removal of many large and revenue-paying brick buildings and improvements, having a frontage of 4139 ft. on both First Ave. and Railroad Ave. (the two principal streets in the wholesale and jobbing district) and containing altogether an area of 654,356 sq.ft. Waterfront and dock property, 408 ft. in width and 970 ft. in depth, was acquired in the vicinity of the local freight-yard property. Terminal-yard grounds (106.2 acres) were acquired within the city limits and about two miles south of the local freight yard. Passenger-station grounds (745,900 sq.ft.) were acquired in the heart of the business district and adjacent to the existing King St. station used jointly by the Great Northern R.R. and Northern Pacific R.R. The general arrangements of the terminals are shown in Fig. 1, which shows also the other railways. The project of the Municipal Commission for removing the main tracks from the congested district along the water front and establishing a central union passenger station is indicated by dotted lines.

During 1909, 1910 and 1911 the development of these properties and provision of terminal facilities proceeded with dispatch. Everything provided has been of substantial and permanent construction, and liberal in extent, in order to take care of the large business which was offered immediately upon beginning operation and the anticipated large increase of the future.

In the local freight yard, 3.76 miles of track have been laid, a steel-concrete freight house 50x320 ft. has been constructed, and all the facilities necessary and usual to a modern freight yard have been completed. The plans provide for 14 yard tracks, 13 and 16 ft. apart, and two pair of team tracks (13 ft. spacing) separated by two 48-ft. driveways. They show also an inbound freight house 50x800 ft. and outbound freight house 30x500 ft.; these are opposite each other, with six tracks between and a central trucking platform 12 ft. wide. The work in the terminal yard (called the Argo yard) includes 391,000 cu.yd. of filling, 12.26 miles of track laid, and the construction of the following buildings: 11-stall roundhouse, machine shop 90x180 ft., store house, power house, oil house, yardmaster's office and lavatory. All the buildings are of reinforced-concrete. A mechanical coaling plant of 500 tons capacity has been provided, together with cinder conveyors; also water, electric light and sewer systems. The tracks in the Argo yard have been laid with new 75-lb. rail. This yard has been planned for an ultimate development (for storage and classification yards) of a capacity of 3042 cars. The plans provide for duplicate machine and erecting shops on both sides of a transfer table, besides car shops and a 50-stall roundhouse.

At the time the passenger-terminal property was purchased the city of Seattle had perfected a plan for filling this site and the surrounding streets by sluicing material from the adjacent hills. Under arrangements made with the city authorities the railway company agreed to construct a retaining wall and surround its grounds with overhead structures, thus providing an entire separation

of railway and street grades in its passenger-yard development. These improvements were completed in April, 1911, and passenger-train service was then diverted from the temporary facilities to the new station building and yards.

The development of these facilities required heavy expenditures and extensive construction work. The station yard being below the new ground level, a heavy retaining wall is required along the east side, and Jackson St. and Seattle Boulevard are carried across the yard on viaducts. To increase the width of the yard and enable a track to be laid under (and parallel with) Fifth Ave., the retaining wall is set back 16 ft. from the street line and a reinforced-concrete floor 24 ft. wide extends from the wall over the yard. A row of columns between the two tracks supports a 16-ft. span of this overhead structure, and the sidewalk is cantilevered 8 ft. beyond these supports, so as to extend partly over the second track. The arrangement is in general similar to that of the Great Northern Ry. on Fourth Ave., which was described in our issue of Mar. 21. The Fifth Ave. retaining wall is 1613.3 ft. long, and varies in height from 31.6 ft. at the south to 51.3 ft. at the north end; it is said to be the highest of its type in existence. All these structures are of reinforced-concrete and were built by the railway company; they required 20,866 cu.yd. of concrete, 2588 tons of steel and 2985 concrete piles.

From Black River Junction (9.46 miles south of Seattle), the entrance into the city is made to the local freight yards by way of the Argo yard, and to the passenger station over a privately owned right-of-way crossing the tide flats. This line was of extremely heavy construction, on account of the necessity of cutting into the hillsides to avoid existing railways and right-of-way, and in the grading there were moved 1,182,463 cu.yd. of material. A double-track main line across the tide-flats, involving an embankment containing 490,000 cu.yd., affords direct entrance to the passenger-station yard. There have been laid already 4.16 miles of track for passenger-train and coach-yard service.

The cost of constructing the passenger station, the bridges, viaducts, retaining walls, etc., essential to the development of the passenger yard, was $1,285,000. This is exclusive of right-of-way, which, on account of its location, was very expensive. The railway has expended also $540,000 in the development of its Argo yard, $110,000 in local freight yards, and $596,000 in constructing the main line from Black River Junction to Seattle. In addition, large amounts have been spent for providing industry spurs and tracks. Thus, since 1909 the Oregon-Washington R.R. & Navigation Co. has expended in Seattle, in the development of its terminal facilities (and exclusive of right-of-way), an amount in excess of $2,500,000.

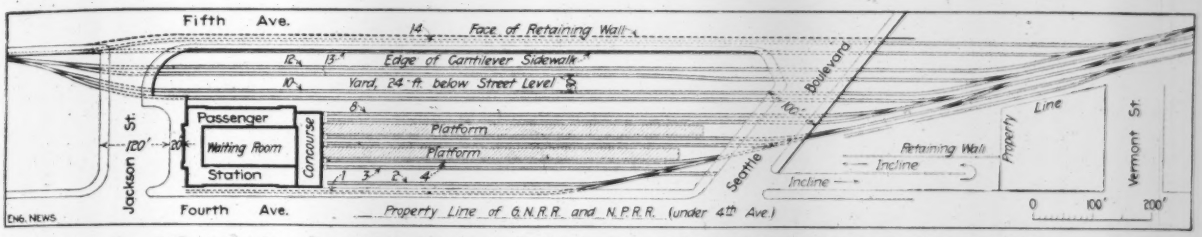


FIG. 2. PLAN OF THE PASSENGER TERMINAL STATION OF THE O.-W. R.R. & N. CO., AT SEATTLE, WASH.

PASSENGER STATION AT SEATTLE

The new passenger station is a handsome building and stands in a conspicuous position, clear of surrounding buildings, and fronting on Jackson St., as shown in Fig. 2. It is a reinforced-concrete and brick structure three stories in height above the street level, with a basement and a mezzanine floor between the street level and the track level. The building is 197½x146 ft., the exterior being of dark-red vitrified brick, pointed with white mortar and trimmed with white artificial stone similar in color and texture to the well known Bedford stone. The main feature is a large waiting room, which is on the street level, 24 ft. above the track level. This is 70x159 ft. and its ceiling forms an arch the full height of the building, 54 ft. 10 in. from the floor to the crown. On either side of this are arranged the ticket office, baggage-checking room, news stand, parcel room, women's rooms, smoking and toilet rooms, a special waiting room for immigrants, the telegraph and telephone offices, and the cab office. On the mezzanine floor (half a story below) are the dining and lunch rooms, kitchen, station-master's office, conductors' rooms and baggage storage.

The rooms at the track level are used for baggage, mail and express, and a large hydraulic elevator connects this floor with the baggage room at the street level. Provision is made also for a freight elevator. Baggage may be delivered at either level, an incline running down from the street. One passenger elevator serves the upper floors, and for the use of invalids or infirm persons there is a passenger elevator from the main floor to the track level. At one corner of the building is an emergency hospital. On the second and third stories are offices used by the railway company.

Outside the rear of the main waiting room is a concourse 45x135 ft., extending across the building, from which stairs lead to the platforms at the track level. The platforms are 20 ft. wide, protected by umbrella sheds (23 ft. wide) extending for a distance of 600 ft. Passengers from trains pass up stairs to the concourse and thence to Fourth Ave., without going through the waiting room. The

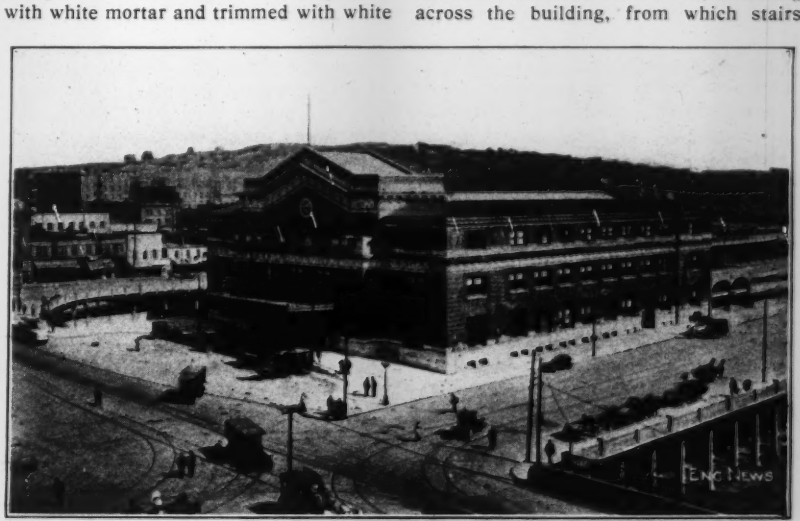


FIG. 3. PASSENGER STATION AT SEATTLE, WASH.; O.-W. R.R. & N. CO.

station has a four-track approach connecting to eight stub tracks and six through tracks; these tracks are arranged in pairs alternately 12 ft. and 30 ft. between centers. South of the passenger yard is the coach-cleaning and storage yard, the storage tracks having capacity for 62 cars.

The main front of the building on Jackson St. has a gable end over the projecting central portion, which is the principal feature in the design; on either side and below the level of this roof are the wings, with ornamental-stone cornice. At the center, on the street level, are three flat-arch entrance openings protected by a large ornamental canopy over the sidewalk. Beyond the vestibule (entered through double swinging doors) the corridor opens into the main waiting room. This occupies the whole central portion of the building. Its arched ceiling is heavily beamed and paneled. From the tops of pilasters spaced 30 ft. apart spring the arched beams; between these are the skylights, having paneled sash glazed with colored glass, affording good light and ventilation. Longitudinal beams intersect with the arched beams midway between the tops of the pilasters and the skylight.

The electric lighting has been carefully planned. The ceiling beams are illuminated by incandescent lights 24 in. apart, and there is a cluster of five lights at each intersection of the beams, making a total of 432 lamps, while on each pilaster are bracketed ornamental clusters. The system is so arranged as to give ample light and to avoid noticeable shadows in any part of the room. At the rear of the room, over the exit doors, is a large semi-circular arch 48 ft. diameter filled with buff-colored glass, and having a clock. As to this window construction, it is stated that no building in the west contains a brick arch of greater span. The walls are in imitation of French Caen stone, wainscoted for 5 ft. with green tile and having an ornamental belt course of two shades of brown. All partitions are of plaster block, having the desirable features of solidity produced by interlocking blocks and wire-mesh reinforcement, and vertical air spaces available for concealing pipes. The floor is of hexagon tile.

In January, 1909, the engineering department surveyed and staked out the site (which is on the reclaimed tide-flats) and work was begun immediately on the concrete-pile foundation. There are 1000 concrete piles 16 in. diameter and ranging in depth from 25 to 50 ft.; the city building department allowed a load of 25 tons per pile. The reinforced-concrete walls and footings surmounting this piling were built to an average height of 7 ft. Work on the superstructure was begun in January, 1910. The frame is of reinforced-concrete with heavy concrete walls up to the first floor (at street level) a height of 24 ft. The concrete is composed of 1 part portland cement, 2 parts clean coarse sand and 4 parts crushed basaltic rock. This is the first building in Seattle in which crushed rock instead of gravel has been used in the aggregate. The company maintained a cement-testing laboratory for this work. Corrugated round bar reinforcing, with spiral wrapping, was used for columns, and square bars for all other reinforcing. An idea of the massiveness of construction is given by noting that the girders under the main waiting-room floor are 66 in. deep, while the columns of the first story are 42 in. diameter. The curtain walls are of brick and stone, steel lintels being used over all openings.

Over the central portion of the structure are six arched trusses of 72-ft. span, constructed of steel angles and plates, and each weighing 15 tons. The bearing plates for these trusses rest on concrete columns. Light steel trusses carry the roof over the two side wings and are covered with interlocking terra-cotta tile. The main roof is a reinforced-concrete slab, sloping 1:3, and is sheathed with asbestos sheets laid in pitch. Surmounting this roof is a skylight 150 ft. long.

Facilities at Tacoma and Grays Harbor

Entrance into Tacoma was first proposed to be an exclusive one, with a tunnel 8671 ft. long. The construction of this was begun in 1908, but when 2250 lin.ft. had been completed, negotiations with the Northern Pacific R.R. were consummated by which the construction of a low-grade line 40 miles in length, known as the Point Defiance line, was determined upon for the joint use of the two companies. The tunnel work was abandoned therefore. Under the terms of this agreement the Oregon-Washington line also acquired joint use of the new passenger terminal and station in Tacoma (ENGINEERING NEWS, July 18, 1912), and these were completed and put in service in May, 1910. The railway then turned its attention to the development of its local freight- and terminal-yard property in Tacoma, and this work is now progressing rapidly toward completion.

From a connection with the joint main line at Centralia, halfway between Seattle and Portland, the O-W R.R. & N. Co. has constructed a 58-mile branch line to Grays Harbor, reaching the large manufacturing cities of Cosmopolis, Aberdeen and Hoquiam, on that port. This branch line involved very heavy construction. It includes a bridge 780 ft. long across the Chehalis River at Aberdeen, consisting of three fixed spans and a 335-ft. swing span. This branch has been constructed according to main-line standards in anticipation of the very heavy lumber and passenger traffic which it will carry. It has been in operation, in sections, for the past year, entrance being made across the bridge into Aberdeen and Hoquiam in September, 1911.

What is to Become of "The Young Old Engineer"

By A Veteran

During the past fifteen years the land has resounded with the cry that this was the age of the young man. Many employers and corporations have fixed a dead line, and men beyond that age are not employed. Perhaps this came as a reaction against the tendency toward relying on old men which had been the rule in the preceding decade or two. Be that as it may, the condition has existed, and has borne hard on many engineers.

There are three courses open to a young man starting in business. He may secure a minor position with some corporation and remain with it, receiving slow promotion with the passing years. He may accept the best position which offers and after a time change to the best position he can get with some other concern, and continue to change in this way. He may accept such positions as offer, save all he can of his earnings and look forward to starting a business of his own as soon as he has sufficient capital.

After 25 years' of work the fellows who went in with the corporation and worked steadily are either in a snug berth with routine duties easily filled, or they have been tempted to some other concern and are either comfortable or miserable, as the case may be. The second class is a very numerous one, and its members find themselves in widely varying positions. The last class usually contains the unhappy and dissatisfied.

Assume for instance a man whom we will call A. B., who came out of college in 1883, went to work for some railway as rodman, was promoted until he reached responsible charge of railroad construction and was then laid off on account of reduction of force. He then went with another road, and spent four years in various lines of location, relocation, construction and reconstruction, and was then dropped owing to a change of management. He then went with a third road, where he spent four years in charge of various building and rebuilding on maintenance. Thus A. B. again finds himself laid off owing to reduction of force in the stress which followed 1893, so he starts out hunting a job. He finds that the older roads have developed the promotion system. The newer roads which are being reorganized often have as General Manager some man drafted from the older roads, who, being unfamiliar with the engineering department, asks the Chief Engineer on the old road with him to recommend some one for the Chief Engineership, and a subordinate from that road comes to him. This man may be younger than A. B. and less experienced. Suppose that A. B. gets a position under him. The

Chief and A. B. have been trained under widely different conditions. The Chief may have grown up under a system of reports, and A. B. under the old conditions of "Don't bother me with the detail, bring me results."

A. B. is in charge of some work and finds that the plans have been made without sufficient data or care and some feature must be changed. It is, as he sees it, of little moment, and he makes the change. Later when the matter reaches the office some draftsman sees the change, calls the chief clerk's attention to it, also the Chief Engineer's, and a sharp letter is written by the chief clerk.

One instance which I knew of was where some yard tracks were shown as 15 ft. apart c. to c. A standpipe was to go in at a point just beyond a bridge, and while the water-service man was at the point the Assistant Engineer asked him if 15 ft. c. to c. would permit the standpipe to be used and was told it would require 18 ft. He had to stake out the bridge that day, so he placed it 18 ft. c. to c. from the old bridge. He was called down very severely for this, and after all the facts had been submitted was censured.

Such conditions make an engineer very uncomfortable. And it is such conditions that an engineer with a dozen years' experience must meet when he has to hunt a job, and finds one under a younger man trained under different conditions.

He is also likely to find himself hampered by the help furnished to him. One engineer was sent out to do some work. Three young fellows just out of college were sent with him, and he was told to get additional help from the section foreman. He reached the place where the work was to be done about noon and in getting the work started set each one to doing something. Two were given axes and told to clear the brush out at one point. The next morning section men were secured for the coarse labor, and the work went on. After returning to headquarters he received a letter calling him down for requiring his helpers to use axes and other tools of labor. To a man who was trained under conditions where no man was too good to do any required work, such nagging is harassing.

But this is not answering the question asked at the head of this article. I have told of a couple of the conditions which have arisen in some men's experience. But we must at all times remember that the Chief Engineer is the man in responsible charge. That he knows that his way will bring the results desired, and that he may know nothing of the way with which you are familiar; and that while your way may be better, that it is for him to elect which will be followed. I once heard a railroad president say to an engineer, "We do not wish to know how you accomplished this in 1896, this is 1908." Our experience is of little value if it has not taught us to improve; but we are only to improve in those things where the decision is left to us.

The old engineer should never forget that schools are at this time different from what they were in his day. In 1900 the writer was placed on one side of a desk to figure strains for changing bridges from the old style to ballast deck, the other side being occupied by a graduate of a prominent engineering school of the class of 1898. The young man had methods of computation of which I knew nothing. Realizing that I could not afford to become a back number in this way, I enrolled with one of the correspondence schools that week. I confess I did not learn the particular thing I sought from that school, but I did learn a host of other things. Another school to whose library I subscribed later gave me the desired information through their inquiry department.

The old engineer can often learn from the younger fellows by asking them how they would do a certain thing. It often happens that these young fellows who fall so sadly in many of the things their course should have taught them will shine brightly in others. It has been of great help to me to make friends of these fellows. I have received many suggestions from them. I do not suppose they are greatly different from the young fellows who graduated with me in the '80's. We developed. Some of us made good. No man is big enough to take in the whole college course during the brief years he remains at school.

But my story article again digresses. Why has the old engineer been discriminated against? Has he been discriminated against? In very many instances he has. The writer was on one occasion relieved from charge of a piece of work on the plea that it was so near completed that a younger (and cheaper) man could handle it. It lasted four months longer, and the pay saved was $220. On the final estimate the contractor put in a claim for about a thousand dollars' worth of work which had been done by the company force, and got it allowed.

That economy was apparent rather than real, although it is probable that I was blamed for the expense.

Perhaps one great reason why the old engineer is discriminated against and why the promotion system is adopted is that it relieves the employing officer of a serious burden. To take the senior engineer who is assistant on some division and put him in charge of some piece of new construction may not bring the best results, and the inexperienced man may be an expensive proposition, but the officer can say he took the best man available under "our system." If all the engineers in the United States were eligible, how would the officers determine which one was the suitable man? How can the best man be found? How can even a competent man be found? With this problem before him is it any wonder the employer shrinks and welcomes the promotion system?

If there was an employment agency in this country managed on a scale large enough to meet this demand it would be of wonderful help. But they have so far failed most woefully. They are planned on a system which gives a greater profit to the agency from the furnishing of an unsatisfactory employee than from a good one. Were they to make their fee contingent upon the employee being retained for at least a year's work and giving satisfaction they would have to secure competent men, fit for the job that is open.

The "Clearance System" of the railways has been so much abused from placing it in the hands of clerks who did not feel the responsibility of what was written that it has been to some extent denatured by legislation.

It seems to the writer there is a strong desire among railroad officials to improve the present system. They see the folly of continually promoting a man of small experience to a position which too often proves too heavy for him, while they know there are men who are fully equipped for the job and who would be glad to take it. They realize that the promotion system may develop into a machine. The man who so conducts himself as to keep his record clear, and who never does an unauthorized thing, no matter what the emergency, is often not the man to cope with an emergency. On the other hand the man who gets into trouble through slipping a cog from the blueprint formulas may have in him the material to cope with the emergency. The mechanical promotion may deaden initiative.

I was recently in a railway headquarters and saw an order sent out to division officers that no more inexperienced men be sent out with trains on the main line. I was told that in the preceding ten days there had been thirty accidents and near-accidents due to recently promoted conductors or enginemen getting mixed as to their duties in an emergency. We cannot in our work get a close line on similar losses in the civil engineering department, but they are there.

Whether this is to continue or not is to a great extent dependent on the engineers themselves. Let the man of 50 stop and ask himself in what is he better than the young man of today. He will admit at the start that his education is inferior and he will put forward his experience. Will be candidly ask himself if this experience has broadened him or narrowed him?

You have experience on reconnoissance. Has this been confined to a single district, or have you worked under widely varying conditions? Could you go into a country where a new job is located and be better for what you have heretofore done? Would you be handicapped because of the work you have done under different conditions?

There are two books covering the subject of reconnoissance, preliminary and location. One gives in a broad general way the principles which must govern all such work. The other gives methods which were followed in a comparatively limited district. I have often thought that if we could know which of these books the applicant for a job as locating engineer preferred, we could judge his fitness for work in either of these lines.

Will the engineer ask himself if the fact that he has passed on the resources of a country mainly agricultural fits him to judge the resources of a coal region? Suppose he has worked in a mining district, is he qualified to pass on the advantage of building into a timber district? Is it not possible that your very experience has actually diminished your ability to judge the particular work? May it not be possible that your experience running a preliminary in a mountainous region where your line is strictly the choice between the two sides of a valley, or between two valleys, may actually handicap you when placed in easy country?

The writer himself had been working for two years along the south shore of Lake Superior, where he was allowed a 2% gradient, when he was ordered to eastern Nebraska, where he was limited to 0.8% grades and given a job of location in prairie country. He recalls that when he plotted the profile at noon time he found that the maximum gradient left him with a 30-ft. cut in open prairie. Could a novice have done worse? Was I a better man for my company at that place than if I had never taken out a party? A man of 60 is liable today to be useless as a locating engineer. Unless he has made himself familiar with operating conditions as they exist now, and with the action of the locomotives now in use on the road for which he is working, and of those which are contemplated, he cannot do the best for that road except by accident.

Will you ask yourself if you have done this? You may have such an imperfect knowledge of operating conditions that your work will be that of a novice. Do you know the effect of modern conditions as affected by improved equipment for doing the grading? A cut that is so small that it will not pay to put in heavy equipment may cost 40c. a yard to move, while if it were heavy enough to warrant the installation of other equipment it could be moved for 15c. If you do not fully understand this, and the conditions under which a heavy steam shovel or a floating dredge works, you cannot do the best work on location in certain localities. These are but two of the many new conditions affecting the locating engineer's work.

If you are applying for a position on maintenance, in what has your experience qualified you for the place applied for? In the last analysis your value on maintenance work varies with your ability to stretch the accomplishment of a dollar. What will do for a road in the Eastern and Central states, where the earnings exceed $8000 per mile, will not do at all in the South and Far West, where the earnings may be one-fourth of that amount.

Within the past year a railroad officer was retired on a pension who had as unpromising a start in life as often falls to one's lot. In 1877 this man had advanced to the grade of section foreman and was working on a railway in Illinois which had been built ten years too soon and was in the hands of a Receiver. The Receiver was a lawyer, and held the view, not uncommon in that day, that all moneys kept out of track expense was money saved. It was a dirt roadbed, the mud of Illinois at that. Ballast could not be had. The joints were the old "fish plate," or, as we now call them, straps. The engines had recently been changed from wood to coal burners. Our man discovered that this engine cinder could be used for ballast. He rigged a platform on the other side of his hand car from the water barrel on which to put a box, and each morning he took out enough cinder to put up one joint. This was a small thing, yet by this daily work he had at the end of a year a mile of track with joints on cinder. After three years the road was taken out of the Receiver's hands and the new manager was a man who knew a cross tie from an expense voucher and looked into things. He soon discovered that Section 6 had fewer derailments than others, and he found out the reason. A man who could use little things and make a betterment was the kind the General Manager wanted, and he made the Section Foreman roadmaster, a new office on the line. Three years later the Manager went to a large system and the Roadmaster went with him to a newly created office of General Roadmaster. Ten years later the General Manager became President and the General Roadmaster became General Manager, to be drafted two years later by another line, from which he recently retired on a pension.

It is true that not every boy who goes to the city becomes a merchant or a railroad president; but none of the boys who stay on the farm ever becomes one. Not every engineer who studies the basic principles of railway economics will become a General Manager; but the fellow who does not do it will certainly not become one. If you ask for a maintenance job, can you promise an improvement in conditions? Are you better qualified for that particular job than some man with fewer service years? Can you maintain the track to a safer standard with the money available than it is now maintained?

An educated civil engineer can make out his reports in better shape than a promoted section foreman. Can he get more ties under the track to the man or surface more feet or raise more low joints? Unless he can, he will not have any secure claim to the job. He must get his work better done at the same cost or equally well done at a less cost if he is to have a claim on the job. On a road of light traffic let us assume there are two foremen having each three miles of very bad track, and each are given 3000 cross ties. A proceeds to full tie one mile. He has two miles of unsafe track still which is a menace to traffic, and his section is no safer for travel than before. Actually the ties have accomplished nothing in the operation of the road. B spreads his new ties over the whole bad section, putting in two new joint ties, and new ties at center and quarter and has his entire section safe for the traffic which offers. B may be no better a track man than A and in the ordinary run of work accomplish no more, but he is vastly more valuable to the company, even if the company never knows it.

If a civil engineer is to be valuable as a track man he must use his head. The man who will rail against the labor or the material which is available for the work, earns nothing for his employer. The man who takes inefficient labor, studies its traits and increases its accomplishment is valuable. Of course you may do all this and never reap other reward than the satisfaction which comes from work well done. But unless you do do these things you will never permanently progress.

As to the outlook for the old engineer, it appears to me to be improving. With the advent of the typewriter the capacity of the official was greatly widened. The manipulator of the typewriter has been helped by the business colleges and publications in devising a system of reports, records and other devices for increasing the employment of the one handling the typewriter. As most chief clerks come from the ranks of the private secretaries and most of the private secretaries from the stenographers, it has been easy for these reports to get a foothold. The system of reports has been a shield behind which the cunning one could conceal his shortcomings, and gave the office man a large advantage over the field man. The recent tendency seems to be to reduce the mass of correspondence by making all the division

officers a family with one file and one filing clerk, with assistants, if needed, in charge of all. The division superintendent does not write a letter to the division engineer or division master mechanic, but calls him, as one of his assistants, to his desk or car. On the Harriman system this has gone a step farther, and the chief clerk has been put back to a clerk's place. When the responsible officer is freed from the mass of records and dictation, and meets his assistants face to face, the ability or lack of ability will come to the front. When the division engineer has to meet the division superintendent and explain the trouble at a certain point, he cannot refer the letter to the roadmaster. If he is too small for the job, the promotion system will not long protect him.

As the departments higher up are brought into closer touch, there will not be the class rivalry and dissensions which have held so many incompetents in a job because the Superintendent would protect his men, the Engineer his and the Master Mechanic his. It will be more likely to bring to the front the man who is responsible for the fault which led to the trouble. And the fruit of it all will be that fewer inefficients will be able to shirk the results of their incompetence. Thus there will be a demand for the competent men.

If this demand be urgent, with it will come a method of keeping men's records. With the dethroning of so many of the chief clerks will come a clearer sense of responsibility. If one manager feels he must depend on the word of another as to the fitness of a man, the sense of responsibility will keep him from endorsing unfit men and will keep him from knocking a good man for incurring his displeasure. It is now not uncommon to hear an officer say, when it is said that some other officer condemns a man, "I would sooner hire a man he condemns than one he recommends." It will be recognized that some lines of work are of greatly varying volume; that a road may require more engineers this year than last or fewer engineers. It will be recognized that to attempt to always promote our own men may not always be best.

Take the other lines of work open to the engineer. The work of municipal and county engineers has grown in volume immensely of late years. Many engineers fail there disastrously because they do not sufficiently study conditions. Good roads and drainage are unusually great problems, and ability to handle a transit or level are among the least of the requirements. It is essential that the engineer know how to deal with the county officials. The engineer in dealing with these men must possess infinite patience and unlimited tact. That the alderman or county official should be ignorant of very simple physical facts is no more surprising than that you should be ignorant on some fact about which you consult a physician. Replying in such a way as to humiliate such an one does not help you. If you can foresee the matters before they come up, and consult with each member, and see that they understand the matter, you may greatly help yourself. You will be less apt to fail as city engineer or county engineer, or as engineer for some board from lack of engineering knowledge than from lack of knowledge of human nature. A job as city or county engineer is a very nice job for a man of middle age. It gives him the opportunity to live at his own home practically all of the time. He will, if he has sufficient tact, find himself a figure of increasing importance in the community.

It is seldom possible in fixing a street grade to get the best possible grade. It calls for going over the route step by step and considering on the ground not only how it will affect the front of the houses, but its bearing on the back yard. You are one of the officers who in a large degree are responsible for the health of the community. It will be an education to the average engineer to read a little two-dollar book by Prof. Mansfield Merriman on "Sanitary Engineering."

I wish there were some way to impress on the mind of every engineer that mere age does not insure fitness. It is possible for a man to deteriorate from industry as well as from indolence. I have in mind an engineer who has been in the employ of a certain company for 27 years. He has been Assistant Chief Engineer for ten years. The post of Chief Engineer became vacant by the disability of the chief. It was given to a man who was younger by eight years than the assistant, and who, 20 years ago, was his subordinate. Why? The Assistant Chief began early in life to overwork. He would work full hours in the field and then long hours in the tent or hotel. He would do a full day's work in the office and take a bundle home with him, where he had a desk. He took fewer and fewer papers, and ceased to read even those he did take. He read no new books; his "Trautwine" was the edition of 1881. Whenever any unusual work came up he was unable to cope with it and an outside engineer had to be called in. This man was in 1910 just where he was in 1883, except that he had forgotten some things and acquired increased facility in doing others. He had not grown with the years.

Where does the railroad engineer of a small road stand today if he has not kept in touch with the development of signal engineering? He does not need to know all about it, but he must be sufficiently conversant with the several systems to be able to make clear to his superior the advantages of each to their road at the particular point under consideration. He must keep in touch with the development of cement and concrete development as it affects his road. It has come about that a railroad station can be built in most parts of the country of concrete and stucco with a tin-shingle roof for about the same cost as one of wood throughout, and the structure will have greatly increased the safety and durability. But the engineer who works nights on routine work will never find out these things.

If the engineer is to be essential to his road, he must become such through the work of his head, not wholly by his hands nor by using his head in routine work. Ten years ago the writer did not know what a barograph was. Today he would not like to undertake a reconnaissance without one unless he was near an office of the Weather Bureau or in territory mapped by the Geological Survey. How many possibilities there are for increasing efficiency of which he is ignorant he cannot guess.

The question as to what shall become of the old engineer is in a very large degree to be answered by the individual engineer himself. If he grows out of date either through too great a devotion to routine or through laziness, he will have to give way to the younger man who is better educated and who can acquire experience more quickly than he, or at least can assimilate it more quickly.

But if as he grows old he acquires a ripened judgment and adds daily to his knowledge in his particular line, and above all acquires the capacity to use all that he has acquired, he will find his years a small handicap.

There are, it is true, a number of roads where he cannot secure employment, but should he secure employment there he would perhaps not find it congenial. A road which develops its own men also often develops a routine which is galling to one not bred to it. The cry against men of 45 and over was from men many of whom are long since out of service. One of the appeals which the promotion system makes to the officer, is that it frees him of much of the worry of selecting men, since promotion goes very largely to the man with the best record.

I believe our roads are now developing larger men mentally. I believe our officers are growing away from routine; that the chief clerk is destined to be come a clerk and cease to be an executive officer; that we are approaching an era where personality will count; that it behooves the men no longer in the first flush of youth to see that they are fit for the job they hold, fit for the job next above and fit for the job they may apply for, and then to bend their energy to making themselves invaluable in the place they now hold. It seems probable that then the old engineer himself will settle what is to become of him.

Letters to the Editor

Destruction of Concrete Between Tides in Seawater

Sir—As an interested reader of your valued journal, I beg to contribute a few remarks on the question which was discussed in your issue of July 4, 1912, "Destruction of Concrete between Tides in Seawater."

Mr. McKenzie properly remarked that it is very important to know where concrete may be used and where not. I would add to this, however, that it is just as important to know how concrete must be mixed and used to suit the purpose in hand. Here in Germany, too, there have been unfortunate experiences with concrete in seawater, but over against this is a large number of satisfactory experiences. It is very well known to us that seawater must not be used in mixing the concrete, and for that reason we use only fresh water in the latest concrete and reinforced-concrete construction along the coast. Further, we recognize the fact that concrete may only then be used successfully in seawater when not only its initial strength is high, but also its surface is made very dense, because this condition prevents attack, particularly in the earlier period after setting. Therefore in marine construction in Germany an addition of trass is used, which gives to the concrete those qualities which make it suited for marine construction, namely, great denseness and high initial strength.

E. PROBST.

Linkstr. 25,
Berlin, Germany, July 17, 1912.

Concerning Membership in the American Society of Civil Engineers

Sir—Doubtless all members of the American Society of Civil Engineers have been impressed with the clear-cut and timely recommendations, included in the address delivered at Seattle on June 25 by President John A. Ockerson.

Personally, the writer is glad to note the insistence that every one connected with the society, as far as may be practicable, should take a personal interest in the admission of its members, and all must agree that such admonition cannot be too frequently repeated, if the high standards of the past are to be the measure of the future.

Continuing in the same connection, Mr. Ockerson says "if this duty, common to all members, is conscientiously performed, the simple fact of being a member of the society will be of far greater value than any license that could possibly be given by legal enactment." The president goes on to say that under such carefully guarded conditions "membership would at once be a certificate of qualification to design and successfully direct engineering work," and would more surely protect the employing public from incompetent men.

While all of us should like to see such conditions actually exist, and would fain "hitch our wagon to a star," it is a melancholy fact that with the general public, mention of any connection with the American Society of Civil Engineers generally falls upon deaf ears, and even to the well-informed prospective client it conveys considerably less intelligence than a reference to membership in the Royal Society of Hoo Hoos, or other like orders.

As an amusing illustration, a short time since the writer was visiting for the first time a town of some 20,000 people in connection with an engineering engagement, which had been carefully nursed for a month or more by two young men, both associate members of the society, and both wearing their newly acquired blue shields in conspicuous places.

Calling upon a prominent member of the local Board of Public Works, a man also commanding a commercial position worth some $7500 a year, an interview was arranged. Hardly glancing at the card presented, the official merely remarked that perhaps it was not necessary to take up his time by further discussing this matter, as he was rather busily engaged; and, besides, he noted from the society pin (to which he pointed) that the applicant was a member of the firm of X & Y, and that other members of that firm had already during the past month taken up quite a good deal of his time discussing these public affairs!

In view of such experiences, which perhaps are not all confined to the benighted sections of our country, as much as we would like to believe, the writer, at least, hardly feels that the bouquets which President Ockerson presented in the matter of the high regard of the general public for the members of the society have been altogether deserved. But by personal interest and careful scrutiny of those desirous of membership, we can maintain the high standard which now prevails, and can at least feel a sense of pride in possessing one of the blue emblems of our membership, even though it may be taken by outsiders to represent nothing higher than a trade organization or business association.

J. N. HAZLEHURST.

Candler Bldg.,
Atlanta, Ga., July 24, 1912.

Natural Mixture of Sand and Gravel

Sir—In ENGINEERING NEWS, Feb. 8, 1912, p. 257, there appeared a letter, "An Error in Proportioning Concrete," bearing upon the above subject.

It is of interest in this connection to note the stand taken by the former Advisory Board of Consulting Engineers, New York State Canals, as found in the Board's Annual Report for 1910, p. 202:

> The Chairman (Hon. Edward A. Bond), presented a letter from the State Engineer, dated Sept. 2, 1910, relative to sand and gravel to be used for concrete purposes in Contract No. 23, asking specifically if the specifications permit the use of natural mixture of sand and gravel, and the opinion of the Board as to the advisability, from an engineering standpoint, of using a natural mixture.
>
> In reply to this letter the Board desires to state: It is the opinion of the Board the specifications do not prohibit the use of natural mixture of sand and gravel, and that it is not necessary that the sand and gravel in each batch of concrete shall be measured so long as frequent tests are made by the field engineers to determine whether the proportions of sand and gravel in the natural mixture are as called for the specifications. . . . Also the field engineers should exercise care in testing for proportions of sand and gravel in natural mixture as the work progresses.

It would be of interest to learn from the field engineers just what method was employed to determine if the natural mixture conformed to the specifications, 2 sand, 4 gravel; 2½ sand, 5 gravel, etc.

EMILE LOW.

Buffalo, N. Y.,
July 6, 1912.

Crown Curves for Street Pavement

Sir—The proper form of curve for the cross-section of a street pavement and the method of calculating grades for setting stakes to conform to such a curve, when the center height of crown is given, has been discussed so fully in ENGINEER-

ING NEWS during the last year or so that it seems superfluous to attempt to add anything that might be of interest to your readers. However, the writer has used a method, suggested in ENGINEERING NEWS years ago, which is so simple and flexible that it seems strange it has not been used more extensively. I have never seen a discussion of the method and trust the following may be of interest:

In a cross-section having the form of a parabola the ratio of slope of the sections (assumed straight between selected points) from the center toward the curb, vary as 1, 3, 5, 7. Taking the part sums of this series we have 1, 4, 9, 16 as the ratios of the drop of the corresponding grade points below the crown. That is, the drop varies as the square of the distance from the center, which is characteristic of the parabola.

To find the drop at any given point for any given center height we have but to divide the center height by the final sum of the series for any number of spaces into which we wish to divide the half width of street, and multiply by the corresponding part sum.

In a four-spaced section of this form the slope at the crown is only $^1/_7$ that at the curb, making the center of the street too flat, as stated by Mr. Whinery in your issue of June 6 last.

In order to remedy this, suppose instead of slope ratios of 1, 3, 5, 7 we use 1, 2, 3, 4. Our crown slope now is ¼ that at the curb with a gradual increase in slope from crown to curb. This form of curve then would be an improvement over the parabola, and the grade points would be determined in the same manner.

The curve which Mr. Whinery proposes has a curb slope 2.2 times the crown slope which corresponds to the series 2.5, 3.5, 4.5, 5.5, as the ratios of the slope. We will calculate the grade points for this series and compare the curve with Mr. Whinery's.

Taking the part sums in regular order we get 2.5, 6.0, 10.5, 16.0, from which we could calculate the drop below the crown, or as Mr. Whinery figures up from the base line, we will take the part sums in reverse order, 5.5, 10, 13.5, 16.0 to figure the elevation above the base line.

Assuming a rise of crown of 1 ft. our elevations then are $\frac{5.5}{16}, \frac{10}{16}, \frac{13.5}{16}, \frac{16}{16}$ of the given rise, or in decimals 0.344, 0.625, 0.844, 1.0. Comparing these with the decimals in the last column of Mr. Whinery's table which correspond to a 1-ft. rise, we find that the curves are identical. For any other center height we simply multiply the given height by these decimals.

We have used four spaces in the above discussion for the sake of comparison only. The method is perfectly general and is applied in the same manner to any number of divisions.

For a narrow street, say 30 ft. wide, two spaces are sufficient, and if we use the first part of the above series 2.5, 3.5, and assume a crown height of 0.5 ft., we will get for the rise of the one intermediate point 0.292 ft., which would correspond with 0.313 ft. at the middle point of Mr. Whinery's four-spaced curve for a 30-ft. street, a difference of only ¼ in. Had we used 1.5, 2.5, as our series we would have agreed exactly.

The writer does not use decimal series as above in his work because simple numbers can be chosen which give very satisfactory curves. For asphalt streets, 1, 2, 3, 4, etc., gives a satisfactory curve, while 3, 4, 5, 6, etc. or higher is better for water-bound macadam.

It will be noticed that these curves are perfectly regular for any number of subdivisions, the offsets from the straight line, from the crown to the gutter, being equal at points equidistant from the center of the straight line. The straight line is the limit of the curve which it approaches as the numbers in the series become larger.

The engineer has the option of using any crown, any number of regular spaces and any series of numbers to give the form of curve that suits him best, and the method of finding the elevation of the grade points from this data is so simple that it does not have to be remembered.

F. A. STEIGER.

Civil Engineer,
Vacaville, Calif., July 18, 1912.

The Autoclave Boiling Test for Cement

Sir—One of the most interesting and important articles which has appeared in recent cement literature, is that entitled "Autoclave Boiling Test for Cement," by H. J. Force, Chemist and Engineer of Tests, D. L. & W. R.R., which appeared in ENGINEERING NEWS, June 13, 1912, p. 1111.

The article is not only of interest and importance in itself, but also from the fact that it represents the voice of the consumer, whose influence should be powerful in shaping the trend of cement specifications, particularly where, as in this case, the conclusions are the result of an enormous amount of careful, painstaking and intelligent work.

This indication of thorough study of the product by the consumer should be a matter of congratulation to the cement industry. With the facilities and the type of men which these important consumers can command, they are in an even better position than the manufacturers themselves to study the manufacturers' product and its behavior in work over indefinite periods. Mature consideration of work such as Mr. Force has done, and is doing, will, no doubt, compel a broad view of the matter, and the ultimate effect cannot help being advantageous to the industry. If the consumer is not satisfied with the product, he will, of course, not use it, and an enormous amount of work will thus be lost to the concrete field, where it rightfully belongs, and diverted to the domain of steel.

Where the work is designed to be practically enduring for all time, the consumer is naturally far more interested in quality than he is in a matter of a few cents difference in price, in case it should develop that material to conform to his tests costs slightly more to manufacture; the manufacturer would still further benefit by the increased demand for the product which its more extensive use would automatically effect.

An impartial consideration of the present standard specifications, and of the new D. L. & W. R.R. specifications, together with the lines toward which the latter are tending, will show the strong basis for the requirements which Mr. Force has incorporated in these specifications. The standard specification for fineness, for instance, has remained for years at 92% through the 100-mesh and 75% through the 200-mesh sieve, in spite of the fact that it has for a long time been recognized that material which fails to pass the 200-mesh screen has practically no cementitious value, and that some manufacturers of their own accord are grinding uniformly much finer than the standard requirements, their aim being attainment of superior quality.

If a consumer, for instance, after determining the fineness through the 200-mesh screen, finds that in one case he is using a shipment of cement, of which 25% remains on the 200-mesh sieve, and has practically no cementitious qualities, and in the other uses a shipment which shows only 15% rejection on the 200-mesh sieve, the latter cement is unquestionably worth considerably more to him than the former. This would be conceded even from the standpoint of the unit basis, on which most materials are commercially traded in; an iron ore containing 60% metallic iron would cost more than a similar ore containing only 50%; or a coal showing 14,000 B.t.u. would be worth more than one showing only 12,000 B.t.u. The latter cement shipment referred to shows 13⅓% more material passing the 200-mesh sieve than the former, and, as stated, on the unit basis alone, should be worth that much more per barrel.

The question of the value of cement to the consumer, however, involves a great many more considerations than the simple unit basis, as indicated above in the valuation of iron ore, coal, etc. In the first place, in the great majority of cases, depending, of course, upon the mode of pulverization, the material which passes through the 200-mesh sieve, in

the case of the cement showing the residue of only 15% on this sieve, will be much finer, and contain considerably more of the impalpable powder or real life of the cement, than will the material which passes through the 200-mesh sieve in the case of the cement showing a residue of 25% on the 200-mesh sieve. It is, therefore, not only more valuable on account of the greater amount of its 200-mesh material, but even of more decidedly greater value on account of the superior quality of this 200-mesh material. The 15% material remaining on the 200-mesh sieve, as a general rule, is found to be not as coarse as the 25% material remaining on the 200-mesh sieve in the other case, so that the real, practical advantage in value of the one cement over the other, is far greater than the 13⅓% which a unit basis system would seem to indicate. This fact is more strongly emphasized when it is considered that the material which fails to pass the 200-mesh sieve is not merely inert waste material, but, depending upon its amount, nature and coarseness, a positive source of danger on account of its liability to hydrate at some indefinite future time, with destructive results to the structure in which it is placed.

Investigations of the product over a great many years have developed two important tests indicating the value, not to say the permissibility, of the use of cement. These are, in the first place, the determination of the amount of impalpable powder or true cement which the product contains—the greater, of course, the better. This is practically arrived at by determining not only the percentage which passes through the 200-mesh sieve, but also the sand-carrying capacity of the cement, which, other things being equal, increases with the proportion of impalpable powder. In addition to the standard tensile tests, with mixtures of 1 part cement to 3 parts sand, tests with mixtures of 4 parts, 5 parts or even 6 parts of sand are useful in arriving at conclusions on this point.

In the second place, there is the determination of the proportion of material which it is universally agreed has practically no cementitious properties—that which fails to pass the 200-mesh sieve—and examination to determine the possibility of harm from this ingredient. It is this important point which Mr. Force evidently had in mind in inserting the "autoclave" test in the D. L. & W. specifications, and he stated that the road "believes that the 'autoclave' test will show whether or not the cement contains an excessive portion of coarse granules which do not break up or become hydrated when the water is added to the cement for the setting of the material," and referring to the lengthy investigations which have been made, "it appears from this investigation that the failure of cement to pass the ordinary boiling test or the 'autoclave' test, is due to the coarse granules of cement."

The conclusions noted by Mr. Force in his article justify the adoption of the "autoclave" test and the requirement of a more finely ground cement than that which merely passes the ordinary specifications. There is nothing revolutionary or unreasonable in these requirements, and the properly manufactured, highest-grade portland cement will conform to them satisfactorily.

A representative sample of one of the standard brands, for instance, was tested in an "autoclave" by the writer, and not only at the 20-atmosphere pressure specified, but also at a pressure of 50 atmospheres, at both of which it far exceeded the 25% increase requirement. The effect of the fine grinding on its sand-carrying capacity was also tested, a brief summary of the results being as follows:

Lab. No. 6883.

Fineness:	Through No. 100, 95.6%: Through No. 200, 85.5%	
Setting Time:	Initial, 3 hr. 15 min.	Final: 5 hr. 25 min.
Soundness:	Steam test, O.K.	Boiling test: O.K.
Tensile Strength:	24 hrs.	7 days.
Neat	370 lb.	740 lb.
1 Cement to 3 sand		370 "
1 " " 4 "		270 "
1 " " 5 "		210 "
1 " " 6 "		155 "
Autoclave test at 20 atmospheres.		790 lb.
Increase in strength		113.5%
Autoclave test at 50 atmospheres.		580 lb.
Increase in strength		56.8%

This brand, it will be noted, conforms to the new requirements without difficulty, and the tests indicate, too, that specifications could readily be made more stringent.

The present standard requirements on 7-day sand tests, for instance, state that a mixture of 1 part cement and 3 parts sand, shall show a strength of at least 200 lb. at the end of that period. The above results are 85% in excess of this requirement; in fact, the briquettes made up of 5 parts of sand to 1 part cement exceed the strength required for the 3 sand to 1 cement mixture.

The consumer is well within his rights in framing his specifications to insure that the product he receives shall be of only the highest grade possible, and in insisting that the manufacturer furnish him with such cement.

BERNARD ENRIGHT,
Director, Eastern Testing Laboratories.
Allentown, Penn., July 24, 1912.

Cement Shipped in Bulk Years Ago

Sir—We note your editorial of July 25, 1912, in reference to shipping cement in bulk as a new departure. Years ago a large quantity of portland cement manufactured in the Lehigh Valley was shipped in that manner. The stock houses built during the early nineties were doubledeckers so that the cars could be loaded in bulk by spouts from the top bins. For many years cement was shipped daily from the Lehigh Valley region to dealers in Chicago and Jersey City in bulk. The writer shipped for contractors for the county jail at Holmesburg, Philadelphia, three cars of portland cement per week in bulk for a period of nine months. All such shipments were satisfactory in every respect to all concerned.

There are many places now where cement could be shipped in bulk to advantage, if the engineers would permit it to come that way.

WM. G. HARTRANFT CEMENT CO., INC.,
WM. G. HARTRANFT, President.
Philadelphia, Penn., July 31, 1912.

Notes and Queries

Fred MacCoy, Chief Engineer of the Esperanza Mining Co., El Oro, Mexico, corrects some inaccuracies in the obituary notice of the late A. P. Herbert, published in our issue of July 11. Mr. MacCoy writes:

Mr. Herbert was not the locator and builder of the "Colima division of the Mexican Central Ry." as the name is generally used in Mexico, for that work was done under the direction of the late Lewis Kingman. Mr Haines probably confused this work with Mr. Herbert's work on the Mexican Pacific Ry., a narrow-gage road from Manzanillo to Colima, which was subsequently purchased and rebuilt by the Mexican Central Ry. This work was done with the idea of ultimately connecting with the old Mexican National Ry., which at that time was making surveys to reach the Pacific coast.

The "Colima division," or as it was known officially, the "Pacific extension," of the Mexican Central Ry., was first located by W. C. Curry, and afterward relocated by O. G. Bunsen, under direction of Lewis Kingman, at that time Chief Engineer of the Mexican Central Ry.

Among the engineers in charge of divisions was D. D. Colvin, whose death by drowning was noted in the same issue of July 11. Mr. Colvin was in charge of the work from Kilometer 199 to Kilometer 205, and an idea of the heavy work encountered may be had from the cost per kilometer of from $75,000 to $150,000.

This was the last work of importance done by Lewis Kingman. I am not writing to detract at all from the well earned appreciation of A. P. Herbert, but to give credit to whom it is due.

Handy Scales for Estimating Earthwork from center line profiles are described by C. A. James, Assistant Engineer, Lehigh Valley R.R., White Haven, Penn., in a booklet of earthwork diagrams recently published by him.

The accompanying illustration shows one of these scales and the manner in which it is used. The slips are made similarly to those described by C. P. Howard in Engineering News of Sept. 13, 1906, p. 268.

However, instead of copying on a slip of profile paper the cubic yards per 100-ft. station for each foot of cut or fill, Mr. James suggests graduating the slips at even tens, hundreds and thousands of cubic yards per 100-ft. station to the same vertical scale as the profile.

The scales are made in sets for different cut or fill slopes, for level sections and for sections having different ground surface slopes. The booklet above referred to is designed to facilitate such computations as are necessary to graduate the scales.

Issued Weekly by the
Hill Publishing Company
JOHN A. HILL, Pres. ROB'T MCKEAN, Sec'y.
505 Pearl St., New York.

Monadnock Bldg., Chicago.
6 Bouverie Street, London, E. C.
Unter den Linden 71—Berlin, N. W. 7.

CHARLES WHITING BAKER, Editor.

Subscriptions payable in advance, $5.00 a year for 52 numbers, including postage in the United States, Mexico, Cuba, Porto Rico, Hawaii, or the Philippines, $7.00 in Canada.

To foreign countries, including postage, $9.00 or its equivalent, 36 shillings: 36 marks: or 45 francs.

Notice to discontinue should be written to the New York Office in every instance.

Advertising copy should reach New York Office by Thursday of week before date of issue.

Entered at New York Postoffice as mail matter of the second class.

CIRCULATION STATEMENT

During 1911 we printed a total of 931,958 copies.

Of this issue, 18,000.

None sent free regularly, no returns from news companies, no back numbers kept beyond current year.

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Engineering News

Bacterial Removal in the Singapore Filters

We received some time ago an elaborate newspaper report, describing the ceremonies at the opening of the new water works, at Singapore. One of the features of the celebration was the distribution to the guests of a souvenir booklet containing the program of the ceremonies, general plans of the new works with a historical sketch, and the chief particulars concerning their construction.

Glancing over this souvenir booklet and the newspaper report for items of interest concerning the new filtration plant, the one fact which appealed to us as extraordinary, was that in the analysis showing the purification affected by filtration, it was stated that the average percentage removal of bacteria from the unfiltered water *was* 60 *per cent.* It seemed so remarkable that a newly completed filtration plant, constructed with the highest engineering skill, should show such a remarkably low percentage of efficiency, that we made inquiry of Mr. Robert Peirce, the engineer in charge of the work as to the accuracy of these figures.

A reply has just been received from Mr. Pierce, in which he states that the copy for the souvenir pamphlet referred to was sent to the printer's hands during Mr. Pierce's absence in Europe. By an extraordinary blunder, an old analysis from some ancient filter bed long since abandoned was substituted for the analysis of the water purified by the new filters. A copy of the correct analysis, submitted with Mr. Peirce's letter, shows an average removal of bacteria of 99 per cent.

Midsummer Floods

The heavy and frequent rains of the last few weeks are proper matter for thought to all who are interested in stream flow in any one of its many phases. Floods have occurred in a great variety of regions, in the smaller streams at least, and at a number of places large rivers have been in flood with destructive effect. This is in a time of the year when ordinarily low-water conditions prevail, the time for which any storage equalization must be held in readiness.

It is long since we have witnessed midsummer floods of this kind, but the rarity of their occurrence must not induce a tendency to leave them out of account altogether. For example, when a reservoir system is spoken of or projected for the control of flow in a given stream, it must be realized that such a system may be quite unavailable in a period which normally should be expected to be a dry-weather period but which turns out to be a time of rain and flood.

The facts bearing on this matter may be generalized even more broadly, we believe. Through a long period of years, floods may be found distributed in all months of the year, more frequent in the regular high-water months but occasional possibilities in any of the other months. To operate an equalization system in the face of these conditions seems a very delicate problem indeed, as the storage may be kept intentionally low at the beginning of what proves to be a period of drought, and on the other hand may be full or nearly so at a time when the unpredictable variations of the weather bring a period of abnormally high rainfall.

Regulation of stream flow as applied to the majority of cases is likely always to mean the provision of arrangement for taking care of the full natural stream-flow variations, merely eliminating the possibility that these variations can cause injury to lives or property. Hopes for a more artificial regulation, one which will suppress the variations of nature and make the hydraulics of the stream as simple as those of an aqueduct, find little support in present conditions.

Live Stock Statistics and the Cost of Living

A bulletin has just been published by the U. S. Census Bureau which sheds more light on the high cost of living than all the deliverances of the politicians or the abstruse theories of the economists. The bulletin shows that the number of cattle in the United States in the census year 1910 was less by over 3,500,000, in round numbers, than the number returned by the census of 1890. From 1890 to 1900 the decrease in the number of cattle in the United States was over 5,000,000, and in the 10 years ending in 1910 an increase of only 1,500,000 occurred. Not only has the number of cattle decreased, but the number of sheep and hogs as well. There were nearly 5,000,000 fewer swine in the United States in 1910 than in 1900, and about 9,000,000 fewer sheep. As for the minor sources of meat production, on the poultry farms, while the number of chickens increased 20% from 1900 to 1910, the number of turkeys decreased nearly 50%, and the number of ducks about 40%.

Thus, while the United States, through its great increase in population from 1890 to 1900, enormously increased its con-

sumption of food, the sources of meat supply from the farms and ranches of the United States *decreased* in that time. It needs no further statistics than these to show that by the law of supply and demand a great increase in the prices of meat and meat products was certain.

While this change has been going on in the United States, there has been no relaxation in the demand for food products from other countries. In Europe the same conditions have existed of a decreasing live-stock supply with an increasing population of meat eaters. Bearing in mind the length of time required to bring about any large increase in the herds and flocks of a nation, bearing in mind also that the heavy draft upon these herds and flocks for current consumption is steadily maintained, and that the high prices of other farm products tend to induce farmers to devote their lands to other purposes than stock raising, it is difficult to see any prospect for a world-wide reduction of the price of meat for a number of years to come. Better farming methods in the United States, and the utilization of waste areas in South America, Australia, and other possible portions of the world, for the raising of cattle and other live stock on a large scale seem the only changes by which the world may hope for an eventual return to lower prices for meat and meat products.

The Current Activity in Business

It has long been a tradition in business circles that the year of the presidential campaign is almost without exception a year of waiting business; 1912, however, is proving an exception to the rule in this respect. Our news columns and our monthly supplement of market prices have recorded during the past few months gratifying activity in building construction and in various lines of contracting and engineering work, and sound conditions in financial circles. Presumably the best index of all as to business conditions is the labor market. It is well known that in the iron- and steel-producing districts of the Central West the supply of labor for some months has not been equal to the demand. It is now reported that similar conditions are prevalent in the manufacturing districts of New England. Managers are having difficulty in increasing their operating forces to correspond with increased sales.

In a large share of American economic thinking and writing it has been customary to trace business prosperity or adversity to conditions on this side of the water solely. We need not refer more definitely to the arguments used by both political parties, which have sought to trace business prosperity or adversity to the policy of the one political party or the other. Those who view the matter from a broader aspect, however, are becoming aware that so far as most of the periods of business prosperity or adversity are concerned, their causes are world wide and not confined to the limits of a single nation.

At the present time it is not the United States alone which is entering upon an era that promises to be extremely prosperous and active. Similar conditions are prevailing in Europe. In England, for example, where shipbuilding is the industry of greatest importance, probably, in the whole field of engineering manufacture, London *Engineering*, of July 12, states that the volume of tonnage now under construction in British shipyards is greater than has ever before been recorded. It gives the total as 529 merchant vessels with a gross tonnage of 1,774,040 tons, and 67 war vessels, for British and foreign navies, with a total tonnage of 503,000 tons. Seventy-three per cent. of the merchant tonnage and 78 per cent. of the warship tonnage are for the British nation.

This news is not only of importance as showing the prosperity of one of the most important industries of a leading commercial nation, but is significant because activity in shipbuilding is an index of activity in the shipping trade, and international trade over seas is probably the very best index we have of world-wide business activity.

Railway Maintenance and Inspection of Permanent Way

That inspection and maintenance should should go hand in hand is almost axiomatic. Good maintenance implies careful inspection and (what is perhaps more unusual) systematic and regular inspection. Conversely, in a well handled organization, inspection and the defect which it may reveal necessarily imply and bring about proper repair and maintenance work.

In spite of this close connection, it is important to keep clearly in mind that the two operations are distinct, and not only require different faculties for their performance, but should, where possible, be kept separate and in the hands of different persons or departments.

For example, it is usual to think of the railway track and structures on our more densely traveled lines as being excellently maintained. Except under dire stress due to lack of funds, most railways provide adequate amounts of money for the maintenance of their roadway. We may add that in our opinion this common belief is fully justified, and that the maintenance of railway track and structures is usually well performed, at least on lines of heavy traffic.

An interesting light is thrown on this subject, however, by the detailed reports of the railway inspectors under the New Jersey Utilities Commission. These reports review separately all the ra[illegible] in the state, and each division or b[illegible] and make note of missing or de[illegible] track parts and defects in structures [illegible] comments on the general condition o[illegible] road.

From these inspection reports we learn that bridges with badly spaced ties, or with some ties decayed, or with the structure in need of repainting, or otherwise defective in minor points, are very common, more common in fact than bridges which are in thoroughly satisfactory condition. Track conditions are somewhat better, though also by no means perfect. The reports indicate that a large amount of repair work is urgently needed on the permanent way of New Jersey railways, chiefly on the bridges. An even more important fact is that recommendations for a considerable number of repairs and changes made by the Commission's inspectors in the previous year have not been heeded, and these recommendations are, therefore, repeated with the brief note that they were made a year ago.

What is said above may give the impression that the defects and deficiencies reported are only in unessential particulars. This would be an erroneous impression, however, as a large number of the points criticized by the Utilities Commission's inspectors are such as directly affect the safety of traffic. It becomes apparent, on reading the reports, that the Commission's inspection is of great importance to the public. Whatever the excellence of the railway's own maintenance work, it falls short of what should be attained, if the criticisms of the Commission's inspectors are well founded.

The Engineer and the Newspapers

In the interesting address of Mr. Frederick H. Newell on "The Engineer in the Public Service," published in our issue of July 25, attention was called to the wisdom of giving proper publicity to the work on which an engineer is engaged.

We deem it worth while to add to this advice the suggestion that any engineer engaged in the public service will find it greatly to his advantage in the long run if he will endeavor in connection with all matters of publicity, first, to keep control of his temper, and second, to treat representatives of the newspapers with uniform courtesy.

Successful politicians fully understand these rules. They know perfectly well that no matter how many invectives a newspaper may be hurling at them, they cannot afford to incur the personal antagonism of the reporters representing that newspaper.

Of course, very few engineers are lacking in courtesy when reporters seek

information regarding their work, merely as a matter of publicity; but when an engineer is under fire and subjected to published criticisms which may very likely be bitterly unjust, a thin-skinned man is very apt to lose his temper, and may attempt to vent his just indignation upon the reporters whom he may regard as partially responsible for the criticisms.

An example of what was probably a case of this sort has just come to our attention in the columns of a newspaper published in one of the large cities in the East. Some local squabble had arisen over the quality of a small stretch of vitrified brick paving. Charges had been published that the bricks were not properly tested before acceptance. Of course, the reporters started out to interview the city engineer, and the result of the interview was given as follows in one of the leading dailies of the city:

> I will not talk about those bricks. I do not care what you say people might think of me for keeping quiet; I will not talk. I will not say a single word about those bricks to anyone.
>
> It would be absurd for me to try to answer everything in the newspapers. They do not treat me fair. They find fault with some little thing and do not give me credit for what I do. The streets are in better condition than ever before.

Doubtless many engineers in the profession can sympathize with the feelings of the engineer who was responsible for the interview quoted; but the unwisdom of allowing one's feelings to control one's words under such circumstances is worth emphasizing. Unfailing courtesy toward reporters will do more in disarming public criticism than all the technical knowledge that an engineer may possess. It is not enough that an engineer is competent, faithful, and honest. The only means that the public has of learning the qualities of the engineers who are in its service is from the stories written by the reporters for the local newspapers. To treat these men with courtesy, therefore, even under provocation, is often important not only to the success of the engineer, but to the success of the work on which he may be engaged.

Wanted: Information on Lubrication: An Opportunity for Profitable Research

With the number of research laboratories in the engineering schools in which graduate students are now engaged in making all sorts of investigations, we wonder why it does not occur to somebody to undertake some much needed work in the neglected field of lubrication.

There is no department of mechanical engineering work, probably, in which the engineer feels himself on as uncertain ground as he does in connection with friction and lubrication. The machine designer may use his best endeavors in taking care of all the static and dynamic stresses in a machine. He may show commendable ingenuity in so planning all its details as to facilitate the work of the foundry and the machine shop, and lower the production cost. He may thus design an excellent and useful machine, and yet his whole work will come under condemnation if under the test of actual trial there develops a tendency for something to run hot.

Every experienced mechanical designer knows that bearings and rubbing surfaces, and provision for cooling and lubrication are the things which he must look out for most carefully; but when he makes a search for published data on friction and lubrication he discovers that there is a lack of accurate data reliable enough for him to base his designs upon them.

We are not referring now to the figures commonly given as to necessary area of bearing surfaces, limits of unit pressures, etc., but to the character and quality of lubricants suited for different classes of work and which can be absolutely relied upon.

Of course, there is an abundance of *claims*. The engineer is beset with this, that, and the other manufacturer of oil, grease and dope, assuring him in most positive terms that they, and they alone, can furnish the lubricant which is certain to give satisfaction under his special conditions. The makers of lubricants claim (and their claim has some foundation back of it) that they can make lubricants to suit different conditions; but they do not tell the engineer why this oil is the proper thing to use for this particular bearing, and that oil is the thing to use for the other particular bearing. They hold this knowledge —if it is knowledge—as a sort of trade secret.

There is a shrewd suspicion among engineers of long experience that a great deal of this talk concerning the merits of different lubricants and the adaptation of different oils for different special uses is based upon a foundation of thin air. There is more or less suspicion that when so called "high-grade" lubricant is sold for 20, 40 or 60c. per gal., it really costs the oil maker and dealer no more than the oil which he sells at a third of the price. Possibly it is even taken out of the same tank.

As far as the testing of lubricants is concerned, it would seem that there has been very little development in the art during the past score of years. The results obtained from lubricants tested on the standard oil-testing machines have shown such wide variation and have proved so poor an index of the practical value of the oils as lubricants, that one of the most prominent college testing laboratories has, we believe, given up entirely the practice of lubricant testing, and advises clients to try their oils in actual service, or to rely upon the representations of the makers and sellers.

Certainly, this is not particularly creditable to the mechanical engineering profession. It ought to be possible to devise a machine which would actually do to an oil what use in service does to it. A new oil-testing machine has recently been described in London *Engineering*, of June 28, in which lubricants can be tested at speeds of from 50 to 3000 r.p.m. with pressures of 1 lb. to 750 lb. per sq.in. and with temperatures of the rubbing surfaces as high as 450° Centigrade. This seems a step in the right direction; and according to our contemporary's account, the machine has produced practical results in the testing of lubricants which were not hitherto possible with the older forms of oil testers.

The need for advance in this field of lubricant testing is becoming serious because it is becoming necessary in order to meet present-day requirements in machine design to use rubbing surfaces under conditions which would formerly have been considered impossible. Speeds, pressures and temperatures are all being used under modern conditions which would formerly have been considered quite out of the question; and lubricants to meet these severe conditions are being used (and we suspect made) in a rule-of-thumb way, involving a great deal of trial and error, and a good deal of disappointment and trouble among machine designers in the endeavor to find a lubricant which will meet their special conditions.

Not only is there need for more accurate engineering data as to the qualities of the different lubricants in general use, but there is need for investigation also to determine the possibilities in the use of new lubricating materials. We refer particularly to *the use of solids as lubricants*. A great deal of work has been done by two prominent manufacturing concerns in exploiting the merits of graphite as a lubricant, and there is a considerable amount of data scattered through technical literature bearing on experience with graphite used alone and in combination with oil and grease. Yet how little of this data is authoritative, so that the engineer feels safe in relying upon it? For one thing the claims of the different manufacturers diametrically conflict in some respects, and again it is known that certain trials with the use of graphite as a lubricant have been disappointing on account of the wear of the rubbing surfaces. Is there any way by which the engineer can be enabled to purchase lubricating graphite with a certainty that the material he is obtaining will produce satisfactory results?

Again there are other solid materials which are of possible use as lubricants. Mica ground to an impalpable powder has been quite extensively used as a lubricant. A voluminous monograph on mica by Hugh S. de Schmid, M. E., just

issued by the Canadian Department of Mines, says:

> As a lubricant, pulverized mica is much in demand, being to a large extent frictionless; and even the finest grades having capillary attraction, the flakes hold the oil or grease to the bearings. In addition the flakes adhere to both parts of the bearing, and receive a large amount of the wear.

One can find similar fugitive quotations in technical literature regarding the use of mica, but where have any experiments ever been made to determine the comparative merits of mica and of graphite as lubricants, or are there places where the one would give better satisfaction, and other places where the other would be preferred? Still another possibility in solid lubricants is powdered talc and it is said to have been actually used in some cases as a lubricating material, probably mixed with grease. What are the possibilities in the use of any of these materials alone, as lubricants? In some of the machinery used in metallurgical operations, there are bearings subjected to heat so intense that it is very difficult to find an oil or grease which will stand any length of time without burning up. Could solid lubricants be used in such locations to advantage? An even more important possibility is the cylinder lubrication of internal-combustion engines of all classes.

One of the greatest problems of lubricant makers in the past dozen years has been to produce a satisfactory oil for this purpose. After striving for years to produce a high-test oil which would withstand the fierce heat of the combustion chamber and still produce satisfactory lubrication, the practice of lubricant makers has within the past year or two entirely changed. Instead of making a high-test oil, the practice now is to use an oil which will be burned up comparatively readily, so that all the oil not actually used to lubricate the moving pistons will be promptly burned up as fuel, and will leave no residue to clog the piston rings.

As a result of this practice, hundreds of thousands of gallons of expensive oils are being burned up in automobile and gas-engine cylinders as fuel, of which only a small percentage is actually effective in lubrication. The three solid lubricants which we have named, however, are each of them unchanged in their constitution at very high temperatures. It ought to be possible by their use either to dispense with oil entirely in lubricating gas-engine cylinders, or to reduce the consumption of oil to a comparatively small amount.

We trust these suggestions will fall under the eye of some of the college research laboratories in search of new worlds to conquer, and may serve as a stimulus to induce them to take up the study of this important and hitherto, so far as we know, untouched problem.

Rules for Lathing and Plastering*

1. **WOOD LATH.**
   - a All wood lathing shall be done with the best quality sawn white pine or spruce laths set not less than ⅜ in. apart for lime or lime and cement mortars and not less than ¼ in. apart for hard wall plaster mortars.
   - b The lath shall not be less than 1¼ x ¼ in., nor wider than 1½ in.
   - c The wood shall be well seasoned and free from bark, sapwood or dead knots.
   - d All wall and ceiling lath shall be nailed with at least four nails to each lath where studding or furring is 16 in. on centers, and with five nails to each lath where furring is spaced 12 in. on centers.
   - e Lath in walls shall be laid horizontally, and in ceilings shall run in one direction only. The joints shall be broken at least every tenth lath.
   - f Three-coat work, scratch, brown and finish coats, shall be required on wood lath.
2. **METAL LATH.**
   - a All expanded metal and sheet metal lath shall be not lighter than No. 27 U. S. gauge, galvanized, painted with an asphaltum compound, or japanned.
   - b All wire lath shall be not lighter than No. 20 U. S. gauge, galvanized, painted with an asphaltum compound, or japanned.
   - c All metal lath shall be lapped at least 1 in. at the ends, and at the sides of the sheet the lath shall be lapped in such a manner to insure a good job.
   - d All expanded sheet metal and wire lath shall be of a type suitable to form a proper key and firmly retain the plaster.
   - e In furring over structural sheathing or solid woodwork, metal lath shall be kept at least ⅜ in. away from the wood surface by furring strips.
   - f All metal lath without stiffeners shall be tied or laced at least every six inches vertically to the furring or studs with No. 18 U. S. gauge annealed, galvanized wire, and all lath with stiffeners at least at 8-inch intervals; at lap joints horizontally, between the studs, a similar tie shall be provided. The ends of all tie wires shall be twisted tight with a double turn and bent back flush with the face of the lath.
   - g Expanded or sheet metal lath of No. 24 gauge or less fastened to wood studs, shall be stapled at least at 6-inch intervals and the laps between the studs securely laced. All stiffened wire lath on wood studs, shall be stapled over the rod or "V" stiffener, and the laps between studs properly tied.
3. **FURRING AND STUDDING FOR METAL LATH AND PLASTER OR PLASTER BOARD PARTITIONS AND CEILINGS**
   - a All furring or studding for metal lath and plaster partitions shall have a minimum spacing of 12 inches and a maximum spacing of 16 inches corresponding to the lath as specified in Table 1.
   - b All furring in ceilings shall have a minimum spacing of 12 inches and a maximum spacing of 16 inches corresponding to the lath as specified in Table 1.
   - c See Table below.
   - d For both solid and hollow metal lath and plaster partitions, the studs or furring bars shall be 1-inch x ⅔-inch x ¼-inch, channels or angles, tees or flats of equivalent sectional area and strength spaced 12-inch to 16-inch centers according to the lath used. Where necessary, the steel furring strips shall be properly braced and bolted laterally; and shall be securely fastened to floor and ceiling construction by bent knees, slotted clips or runner plates of approved types.
   - e All furring for suspended or clipped ceilings shall be of sufficient weight and strength to support the load imposed and shall consist of at least ¾-inch channels or their equivalent for spans up to five feet and not lighter than 1-in. x ¾-in. x ⅛-in. channels or other approved sections of equivalent strength for spans up to seven feet. The spacing of furring bars shall correspond with the type of lath used. For spans over seven feet, the sectional area and the strength of furring bars shall be increased proportionately or intermediate supports shall be provided, of hangers or clips securely fastened to the bottom flanges of steel beams or anchored to the arch construction above. All supporting clips used for the purpose of receiving and supporting the furring bars for ceilings shall be made from stock weighing not less than 0.4 pounds per lineal foot and of sufficient strength to sustain the dead load imposed.
   - f Cross-furred and suspended ceilings shall be constructed of continuous running bars equivalent in strength and sectional area to a 1½-in. x 1½-in. x ⅛-in. angle suspended by hangers from the lower flanges of the structural steel framing. The cross-furring shall be securely bolted or

TABLE 1

Types of metal lath	Maximum spacing of studding or furring	
U. S. standard gage	Hung and clipped ceilings	Solid and hollow partitions
No. 22 gage expanded metal lath with ribs at least ⅜ in. wide, weighing at least 4½ lb. per sq.yd.	16-in.	16-in.
No. 24 gage expanded metal lath with ribs at least ⅜ in. wide, weighing at least 3½ lb. pe sq.yd.	14-in.	16-in.
No. 24 gage expanded metal lath of less weight	12-in.	16-in.
No. 27 gage expanded metal lath or sheet metal lath		12-in.
No. 18 gage wire lath 2x2 mesh	12-in.	14-in.
No. 18 gage wire lath 2½x2½ mesh	12-in.	16-in.
No. 20 gage wire lath 2½x2½ mesh	12-in.	14-in.
No. 20 gage V-stiffened wire lath or with rods or stiffeners 7½ or 8-in. on centers	16-in.	16-in.

*Regulations for the guidance of municipal building inspectors, drawn by the Bureau of Buildings, Borough of Manhattan, New York City, 1912, to carry out a law passed by the state legislature in 1911 requiring the bureau to inspect plastering in tenements, apartments, hotels, hospitals and other public buildings.

clipped to or passed through the running bars. If "hair-pin" clips are used they shall be of not less than No. 9 annealed and galvanized wire and shall pass up on both sides of the furring bar and be securely hooked over the running bar. The hangers shall be of not less than 1-in.x⅛-in. flats, clamped to both sides of the steel beams.

g Clipped ceilings shall be not morethan 4 inches below the steel beams.

h Bolts used for attaching running bars to hangers shall be not less than ⅜-in. in diameter and for attaching furring irons to running bars not less than ¼-in. bolts shall be used.

i In the case of heavy, ornamental ceiling work, special provision shall be made to sustain the load.

j Proper ventilation should be provided where hung ceilings are used to take care of the condensation of moisture.

k Three-coat work, scratch, brown and finish coats, shall be required on metal lath.

4. PLASTER BOARD.

a All plaster boards consisting of plaster of paris reinforced with strong fibre shall be not less than ⅜-in. thick, except in tenement houses, where a minimum thickness of ½ in. is required, and shall be of a type approved by the Bureau of Buildings.

b The boards shall be spaced ¼ in. apart on all sides and shall be nailed directly to all wood studding or furring with 1¼-in. wire nails at least No. 11½ gage, with flat ⅜-in. heads. The nails shall be spaced not more than 6 inches apart for walls, and not more than 4 inches apart for ceilings.

c The joints shall be broken every other board horizontally on walls, and at right angles to the furring on ceilings.

d All joints and spaces between plaster boards shall be filled with hard wall plaster mortar and allowed to thoroughly set before browning.

e When three-coat work is specified, the joints or spaces between the boards may be filled at the time of putting on the scratch coat, using the same material.

f Plaster boards should not be wet before plastering.

g Two-coat work of hard plaster mortars shall be required on plaster boards of the above description.

5. LIME.

a Lime used for plastering shall be of the best quality evenly and thoroughly burned limestone. It shall be free from clinkers with not more than 15 per cent. of other impurities. It shall slake readily in water, forming a fine, smooth paste without residue in excess of 15 per cent.

6. SAND.

a The sand shall be of angular grains, sharp, properly screened and free from loam and other deleterious substances.

7. HAIR BINDER.

a The binder shall be water-soaked, well-beaten, clean, long winter hair or approved vegetable fibre cut in 2-in. to 3-in. lengths.

8. SCRATCH COAT.

a The scratch coat shall be at least ⅜ in. to ¼ in. thick, and shall be well keyed into the lath. It shall be scored or scratched with diagonal lines nearly through its thickness.

b The mortar shall be mixed in the proportions of one barrel of lump lime, 2½ barrels of clean, sharp sand, and the binder in the proportion of two pounds of hair or three pounds of fibre to 100 pounds lump lime. Or the mix may be proportioned as follows: to 1000 pounds of unslaked lime of standard quality, add one cubic yard of screened, sharp sand and 10 pounds of hair.

9. BROWN COAT.

a The brown coat shall be at least ¼ in. thick and shall not be applied until the scratch coat is dry. It shall be brought to a true plane by screeding horizontally or some other acceptable method and floating to an even surface. The brown coat must be straight and true.

b The mortar shall be composed of one barrel of lump lime to five barrels of sand, with binder in the proportion of one pound of hair or fibre to 100 pounds of lump lime. Or the mix may be proportioned as follows: to 500 pounds of unslaked lime add one cubic yard of screened, sharp sand and 2½ pounds of hair.

10. FINISH COAT.

a The hard finish coat shall be the best quality of prepared finish or well slaked lime putty gauged with plaster of paris, or plaster of paris with marble dust or white sand in combination.

b The mix shall be proportioned as follows: to one part of plaster add two parts of white mortar.

c If sand finish is used it shall be applied before the brown coat is quite dry, or if dry, the brown coat should be be wet down and the sand coat trowelled or floated to the desired finish.

11. MIXING.

a **Scratch Coat.**
The lime shall be thoroughly slaked, the putty being allowed to cool before incorporating the hair to avoid burning. The proper amount of sand shall then be added and thoroughly mixed and the mortar banked for at least three days.

b **Brown Coat.**
The mortar shall be prepared as for the scratch coat, and banked for at least three days before using.

c **Finish Coat or White Mortar.**
The lime shall be thoroughly slaked in a box, mixing in a small proportion of white sand or marble dust. It shall be then run through a No. 10 mesh wire sieve into a storage box and allowed to stand for at least 48 hours before gauging with plaster and applying the finish coat.

d Machine-mixed mortar shall be made from lime putty.

e Hydrated limes of approved brands may be used in place of lump lime.

f All frozen mortar shall be discarded.

12. PLASTERING NOTES.

a All plastering on lath in tenements, apartments, hospitals, schools and other public buildings shall be known as three-coat work, namely, scratch coat, brown coat and finish coat.

b On brick and fireproofing, all plastering shall be done in the brown and finishing coats. Where waterproofing is applied to the interior surface of the wall, the same shall be furred down before plastering, or the mortar gauged with plaster of paris.

c When plastering is applied to concrete surfaces, the surface shall be clean, free from oil and properly prepared for binding and keying the plaster, or the work shall be furred down.

d Walls of brick or stone must be thoroughly cleaned and the joints left rough or open before the plastering is applied.

e The brown coat shall be well floated to a true and even surface flush with the grounds.

f No "laid off" work shall be permitted, but each coat shall be thoroughly dry or set before the next coat is applied.

g All surfaces shall be straightedged in every direction, ceilings level and all jambs and angles straight and true.

h When plastering is done, the building shall be kept in working condition and properly enclosed against the weather.

13. GROUNDS.

a **Base Grounds.** In all rooms and halls there shall be a base ground or what is known as a ribbon ground. Soldier grounds can be placed from floor to ribbon ground, and if such are used, they must not extend out past ribbon grounds or partition plates on floor. Where picture moulding or Dutch shelf grounds, etc., are used, they should receive the same treatment as the base grounds.

b **Window and Door Grounds.** All windows shall be grounded top and bottom unless equivalent provision is made through the use of window frames.
All door, portiere or grill openings shall be grounded top and sides with bucks formed by turning joist on 4-in. way, or with a plain ground which shall not extend past base or moulding grounds.

c On brickwork, concrete and terra cotta, ½-in. grounds shall be used. Where wood lath is used, the ground and jambs shall project not less than ⅞ in. from the stud, and where metal lath is used, not less than ⅝ in.

14. BATH ROOMS TILE ON METAL LATH.

a Where bathrooms are furred with metal lath to receive tile, the mortar shall be composed of one part of portland cement, three parts of clean, sharp sand and ten per cent. of lime putty or hydrated lime with sufficient hair.

b The scratch coat shall be well keyed into the lath and scratched with diagonal lines to receive the tile.

15. CORNICES, GROINED DOME AND

a All cornices, coves and bull noses shall be run with moulds and properly furred and metal lathed.

b Ornamental ceilings shall be constructed in a manner similar to suspended ceilings with the necessary modifications of brackets, frames and supports to conform to the required outline. All furring should be bolted and clipped together and securely anchored. No furring shall be tied up.

16. PATENT OR HARD WALL PLASTERS.

a Hard wall plasters shall be of approved brands and shall be received at the building operations in the manufacturers' original packages and shall be mixed and applied in accordance with his specifications.

17. **KEENE CEMENTS.**

a Keene cements shall be of approved brands, and shall be applied according to the manufacturer's specifications.

b The base coat may be prepared with portland cement in the proportions of one part portland cement to three parts clean, sharp sand.

c The finish shall be well troweled to a polished surface.

Popular Objections to the Use of Sewage on an Irrigation Project

By W. C. McNown*

The Walla Walla Irrigation Co. has for a number of years been working upon the development of several thousand acres of rolling bench land, lying about 16 miles southwest of Walla Walla, Wash., using as its source of water supply the Walla Walla River, which rises in the Blue Mountains.

This stream is largely fed by melting snow in the mountains, so the volume of water in the summer months is greatly reduced, and the company has for some time sought other sources to supplement its summer supply. These conditions led to a consideration of the use of the sewage of Walla Walla, a portion of which has been used by the Blalock Fruit Co. on its fruit and garden land, lying about two miles west of the city, the remainder being discharged unpurified into a small stream just west of the city.

For various reasons it seemed advantageous to obtain the use of this sewage; the city of Walla Walla is a rapidly growing community of 20,000 inhabitants. Its water supply comes from another mountain stream, which will afford an ample supply for many years; thus it was certain that there would be a constant and growing supply of sewage, which in 1910 amounted to about 6 cu.ft. per sec., with a considerable part of the city unsewered. The Blalock Fruit Co. has obtained an abundant supply from artesian wells and was ready to dispose of its rights to the sewage.

In February, 1910, the irrigation company entered into contract with the city to take its sewage for irrigation purposes for a period of 99 years, relieving the city of all responsibility in connection with its disposal, and taking over the unexpired contract of the Blalock Fruit Co. Under the terms of this contract the company is to make proper provision for receiving the sewage at any point on the westerly limits of the city when the discharge at any outfall shall have reached the amount of 2 cu.ft. per sec.

The intake to the company's canal from the Walla Walla River is distant five miles from the westerly limits of the city, and 220 ft. lower in elevation. This is the nearest and most feasible point of delivery, and the company proceeded during the years 1910 and 1911 to build a concrete pipe-line capable of carrying 15 cu.ft. per sec., the size varying with the grade, from 22 to 36 in. in diameter.

The main line was completed in the fall of 1911, ready to deliver the sewage of the principal outfall, there still being needed a branch line three-quarters of a mile in length to reach the other outfall, but this, on account of certain legal difficulties hereafter noted, has not yet been constructed.

It has been the intention of the company to deliver the sewage unpurified directly into its main canal. It will there be diluted with from 10 to 35 cu.ft. per sec. of river water and be carried through 17 miles of unlined canal to the project under irrigation.

The soil through which the canal is built is volcanic ash, and the ditch is maintained in good order, all vegetation being carefully removed from the banks, so that there is small opportunity for solid matters to lodge along them. Most of the solids in the sewage will be disintegrated when they reach the canal, as was shown when the sewage was allowed to run through the pipe line for a few months and discharge into the river below the intake.

The property holders owning adjacent to the company's right-of-way in the bottom lands of the Walla Walla River Valley for a distance of about five miles, are, and have been since the inception of the scheme of using the sewage, bitterly opposed to having it carried in the open canal; they think they see in it a menace to their health by the pollution of the air, and of the ground waters from which they draw their supply of drinking water. Many of them, without legal right, have been using the canal much the same as they would a natural water course for the watering of stock and general farm purposes.

Anticipating such a stand, the company had the situation carefully examined by a representative of the Washington State Board of Health and other prominent engineers and sanitarians, and all were of the opinion that there was very remote possibility of any danger to the health of those living along the canal by the use of it to carry sewage.

As the situation stands at present, no sewage has been turned into the canal. The objecting farmers have united and raised a considerable money to conduct their case; they propose that no sewage shall flow through their lands except in pipe, and the cost of piping through this distance would be excessive on account of the low grade.

The legal status is as follows: The combination of property holders through their attorneys filed a complaint for an injunction permanently restraining the company from running the sewage through the canal as planned, but as yet the action has not been tried on its merits. They also asked for a preliminary restraining order, restraining the company from turning the sewage into the canal until the case could be tried on its merits, but this the court refused to grant. When the company is ready to take this step the case will come to trial.

The residents on the irrigated land were at first pleased with the plan of using sewage on account of the increase in the amount of water available during the summer months, but later there was some agitation and a considerable adverse sentiment aroused. An impartial review of the subject of sewage irrigation and sewage farming, as practiced in other parts of the world, by Prof. Waller, of the Washington State Agricultural College, served in large measure to allay their fears.

In one way the people are sure to profit; it has been a difficult matter to teach them that ordinary canal waters are unfit for domestic use, and some deaths have perhaps resulted from its use; with the advent of the sewage they will at once recognize the necessity of wells or filters.

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30,000 Poles have been eliminated from Los Angeles streets as the result of the joint-pole agreement intered into by nine public-utility concerns about five years ago. Combinations have been recorded on over 21,000 poles. These companies maintain a joint-pole committee comprising one representative from each concern; there is a permanent salaried secretary.

The highest and most satisfactory poles in a given location are selected for joint use where combination is desired. The owners bill the other users for a proportion of the interest on the value of the poles. Where there are no proper poles erected, one of the companies erects such ones and sells a propotionate interest to the other users who transfer their wires and remove their old poles. Where an old line is adequate for the owner's prospective service then a company, desiring to run wires through that section, erects the new poles and the old company transfers its wires and cross arms. The latter concern is given an interest in the new line without cost and its old poles remain its property.

In building into new territory, plans and specifications are submitted to the joint committee and each concern desiring room indicates through its representative. The pole line is built by that company designated by the committee and all users are billed for a proportionate interest.

Condemned joint poles are removed at joint expense and sold at auction; the proceeds are divided pro rata. Old poles may be re-set elsewhere provided they are of proper height and equal to new poles; the part once under ground being considered of no value. (From a paper by J. E. McDonald before the American Institute of Electrical Engineers, Portland, Ore., April, 1912.)

Horace E. Horton

Horace Ebenezer Horton, proprietor of the Chicago Bridge & Iron Works, who died July 29, 1912, was born in the village of Norway, Herkimer County, N. Y., Dec. 20, 1843. He was of strictly Puritan stock. His father's ancestors lived in the eastern end of Long Island for many generations, and his mother's family came from the early Connecticut settlers. When he was 13 years of age, Mr. Horton's parents moved from Norway to the town of Rochester, Minn., in the southeastern part of the state. As a boy, he attended school in Rochester and later went to the Fairfield Seminary in Herkimer County, New York, an institution which within the last decade has passed out of existence.

His engineering ability showed itself early in life. Very shortly after he left Fairfield Seminary, when he was 23 years of age, without any previous experience whatever, or any aid from outside sources except his own reading, he designed, contracted for and built a timber arch bridge in the village of Oronoco, Minn. This was of 186 ft. span and 60 ft. high above the water; in the light of more advanced knowledge of today it was a most efficient structure and thoroughly served its purpose. The success Mr. Horton had with the Oronoco bridge very naturally inclined him to follow this line of work. The country in which he was located was new, and was full of streams where fording was either impossible or dangerous at certain periods of the year.

He kept well ahead of the times and was always able to bring out either new designs or special designs to fit special cases, and naturally advanced rapidly in his business or profession (as one may choose to call it), and certainly he had much to do with the advancement of bridge design and construction.

His first bridges were naturally of timber, this being the most available material. He was, however, one of the first to build the so called combination bridges in which the compression members are of timber and the tension members are of iron or steel. Of these he built a great number in Minnesota, Wisconsin, Iowa and northern Illinois. At the same time, where conditions warranted, he was bringing forth metal bridges, and was one of the earliest (if not the earliest) to use the camelback type of fixed truss (which he used both in metal and in combination bridges) and also the cantilever type. To go through the files of Mr. Horton's offices and look at the many designs of bridges prepared by him over a period of forty years is an intensely interesting study in the history of bridge building.

Several notable bridges were both designed and built by Mr. Horton as engineer and contractor, and as contractor for a much larger number he prepared the detail designs based on general plans. Skill in design, in workmanship and in erection were features of all his work. Five bridges across the Mississippi River were built by him, and the bridge at Anoka, Minn., was one of the first (if not the first) having trusses of the camelback type. His Fort Snelling bridge (opened in 1880) was one of the early cantilever structures, and his design was selected out of 32 competitive designs. It is a deck structure, with three main spans of 135 ft., 270 ft., and 181 ft. The two side spans have inclined end posts projecting beyond the channel piers, forming short cantilever arms to carry a long suspended span. For the Dubuque highway bridge (completed in 1887), both the substructure and superstructure were designed by Mr. Horton. The three main spans

Horace E. Horton

(248½ ft., 363 ft., and 248½ ft.) form cantilevers; the through-truss shore spans include a 120-ft. span at one end and four 225-ft. spans at the other end. For the Lyons-Fulton highway bridge, opened in 1891, Mr. Horton took the entire contract and prepared the detail plans of the superstructure. This has three through-truss spans of 330 ft., a through-truss channel span of 361½ ft., and a 201½ ft. deck span; to give the necessary height at the channel span the approach spans are on grades of 4.6% and 5%. The highway bridge at Winona was designed and built for the city by Mr. Horton; its three main spans of 200, 360 and 250 ft. form cantilevers over the two channel piers. It has pin-connected trusses with riveted floor connections. Further particulars of these bridges will be found in a paper by F. B. Maltby on "The Mississippi River Bridges" (*Journal* of the Western Society of Engineers, 1903). All of them are high-level structures, avoiding the use of draw spans.

His work, however, was not confined entirely to the construction of bridges. In his early days he was an architect of considerable ability. He designed for the State of Minnesota the buildings comprising a hospital for the insane at Rochester, and he built there and in some neighboring cities many schoolhouses and one or two other public buildings. He was, at all times, in great demand among his friends for advice and occasionally for plans for dwelling houses.

Up to the year 1889 he had conducted his business as a contractor, not being connected with any manufacturing establishment, and lived in Rochester, Minn. Realizing the need of having a plant where the material for his works could be manufactured, he, in conjunction with some others, started the Chicago Bridge & Iron Co., and took up his residence in Chicago. The plant of this company was destroyed by fire in 1897. At that time Mr. Horton purchased all the outside stock in the company and then rebuilt the plant and shortly afterward made a transformation in the title and operated the business as Horace E. Horton, an individual, proprietor of the Chicago Bridge & Iron Works. He was never in entire sympathy with large corporations and believed and practiced individual liability for his acts.

In 1894 he brought out a design for a hemispherical-bottom steel water-tank and commenced the construction of the same. The design as perfected by him put the steel water-tank into a distinctly new position commercially. There had been a few steel tanks of this general type built before he took them up, but the design of their details and method of construction were such as to make them so expensive as to put them out of consideration for general use. The two main features of Mr. Horton's system were brought out in his very first design: one was the supporting-column connection on the side of the tank, and the other was in making the bottom of the tank a complete hemisphere instead of a segment of the same. These were the essentials to make these structures practical, and in the 18 years which have elapsed since that time no improvements, except in minor detail, have been made in his ideas, which he determined upon after not more than half an hour's study. The tank built by him at Louisville, Ky., is the largest of its kind; it has a capacity of 1,200,000 gal. and the total height of tower and tank is 200 ft.

This brief review of his work would not be complete without mention of his mechanical ability, which showed itself in a marked degree in the design of machinery of all kinds. The two plants which he operated bore evidence of this

ability, as almost all of the machines were designed and built by him, and some of them have features not possessed by others. He had also a distinctly analytical mind, and could pounce upon the weak points of any design presented to him for consideration with remarkable certainty and celerity.

He became a member of the American Society of Civil Engineers in 1882, and was a Director in 1907 and 1909. He became a member of the Western Society of Engineers in 1881, and was its President in 1895. His technical writings were not extensive, among the most important being two papers presented before the Western Society of Engineers: "The Wrought Compressive Members of Bridge Trusses" (1908) and "Water Storage in Elevated Tanks and Standpipes" (1909). He took part also in the discussion of various papers, including two presented to the American Society of Civil Engineers on "The Halsted St. Lift Bridge" and "Elevated-Railway Design and Construction" (*Transactions*, Am. Soc. C. E., 1895 and 1897). In all such discussions he was emphatic in pointing out that theoretical features in design must be accompanied and tempered by the use of practical common sense. It is considered by those who knew him best that he possessed one of the most brilliant intellects (especially along engineering lines) of the engineers contemporary with him, one of the evidences of which was the clearness of his mental perception in rapidly grasping the points and analyzing the bottom facts of problems or of matters submitted for discussion. And, as in the case of many men of such character, he had a strong tinge of humor in his composition.

On his personal side, the kind words expressed by his host of friends speak for his kindly nature. He was married in 1871 to Miss Emma Babcock, of Waupun, Wis. He is survived by his wife and five children: George T. Horton, of Chicago; Mrs. R. H. Murray, of Greenville, Penn.; Mrs. Karl K. Koessler, of Chicago; Horace B. Horton, of Chicago, and Hiram T. Horton, of Greenville, Penn.

Notes from Engineering Schools

MASSACHUSETTS INSTITUTE OF TECHNOLOGY—The Institute has made, in a course of lectures on aëronautics, what is expected to be the beginning of a department of aëronautical engineering. The lecturer will be A. A. Merrill, of Boston, for many years an investigator in the laboratories of the Institute. These lecture courses will be allied with special work in the departments of mechanical engineering and naval architecture for those who wish to specialize in aëronautics.

The initial course of lectures deals with the early history of the art, with early experiments in flight, with the researches of Lilienthal, Langley, Maxim, Hargrave, Chanute and others, and will also cover a discussion of some of the important features of modern machines, of the dangers of flight and methods of improving the status of the art. Other lectures will take up coefficients of resistance of various surfaces, problems involving the use of resistance coefficients, the mathematics of flight and problems in control systems. The courses of lectures are open to seniors in the department of mechanical engineering and the hours will be arranged so that any student will be free of conflicts.

IOWA STATE COLLEGE—Two scholarships have been established in agricultural engineering. One was founded by the M. Rumley Co., to be known as the Meinrad Rumley scholarship, in honor of a pioneer manufacturer of agricultural implements; the second was established by the International Harvester Co. Each is worth $250 a year to the holder and they will be awarded annually to young men qualified to do special research work in agricultural engineering. The holders for the coming year will investigate the economic importance of the small tractor in agriculture and the use in Iowa of three important machines—the manure spreader, the windmill and the corn harvester.

The first four-year course in agricultural engineering was organized at this institution and the development of this department has been steady, both in courses offered and students enrolled.

A Frame Wharf Collapsed on July 28, at Binz, in Germany, and a crowd of pleasure seekers was thrown into the sea. Twenty-one persons are reported to have been drowned.

A Railway Accident on the Central Brazilian Ry., near Rio de Janiero, Brazil, is reported to have caused death or serious injury to 100 persons on July 31. The accident was caused by the collision of two suburban trains.

A Track Washout on the Chicago, Rock Island & Pacific Ry. at Pueblo, Colo., on July 30, wrecked the Chicago express train No. 6. The roadbed gave way under the train and all but one of the cars was carried down an embankment into the Fountain River. It is believed that at least four persons were killed, including two passengers, although the rapid current of the river has perhaps swept away all the bodies, and made it impossible to ever know the exact number lost. Great difficulty is being experienced in removing the wrecked cars, because the track along the river bank cannot be made firm enough under the present flood conditions to support a heavily loaded wrecking crane.

A Steamship Collision occurred off the coast of Maine early in the morning of July 30. The steamer "City of Rockland," of the Eastern Steamship Co., with 200 passengers, collided during a thick fog with the collier "William Chisholm," of New York. Neither vessel was equipped with a wireless telegraph, and help was summoned by the blowing of whistles. All the passengers of the "Rockland" were transferred to the "Chisholm" and later to the "City of Belfast," without loss of life, although in leaving the "Rockland" a lifeboat was overturned and its occupants spilled into the water.

Collision With an Iceberg badly damaged the British steamer "Manchester Inventor," on July 24. The steamer was bound from Montreal, Que., to Manchester, England, and encountered an iceberg about 15 miles north of Belle Isle straits. The steamer's fore compartments were pierced and filled with water, and it was necessary to throw overboard a deck cargo of lumber before the vessel could proceed to the port of St. Johns, N. F., where it arrived July 30.

A Collision Between the Steamships "Empress of Britain," of the Canadian Pacific Ry. line, and the "Helvetia," a collier of the Chilian Steamship Co., occurred in the Gulf of St. Lawrence on July 27. The "Helvetia" was sunk, and the bow of the "Empress of Britain" was badly damaged. The total loss on both ships is estimated at $750,000.

The Floods in the tributaries of the Ohio River, which caused the loss of life and damage in the mining regions of Western Pennsylvania, noted in our issue of last week, also washed away many highway bridges, some of which were located in Ohio. Belmont County, Ohio, appears from reports to have been the heaviest loser. A 60-ft. steel bridge over Captine Creek was wholly destroyed and many smaller bridges were destroyed or seriously damaged.

The Collapse of a Building used as a dyeing plant by an upholstery firm, in Philadelphia, Penn., on Aug. 1, caused the deaths of two workmen and serious injuries to two others. The building was of brick, three stories high, with wood floors. The second floor is believed to have collapsed under a load of 30,000 lb. of yarn, which was stored there. A 10,000-gal. water tank and an 80-ft. smokestack fell through the roof, following the collapse of the floors below, completely wrecking the building.

The Collapse of the Roof of a two-story brick building under construction in Brooklyn, N. Y., on Aug. 1, caused fatal injuries to one workman and more or less serious injuries to a score of others. The floors were made of steel girders with wood floor joists. The report of the city building inspectors states that the accident was caused by the collapse of the supporting framework, due to insufficient lateral support of the girders and floor joists.

A Large Factory Building Collapsed at Nuremberg, in Germany, on Aug. 2, causing the deaths of at least 10 workmen and injuries to 70 more. There were 110 employees in the building at the time of the accident, and although only 10 bodies have been recovered more are believed to be in the ruins. Newspaper reports state that the accident occurred while officials were applying test loads to the floors.

A Subway System has been proposed for Montreal, Que., by the Comptoirs Financier Franco-Canadien Co., of Paris,

according to a dispatch in the Toronto "Globe." This company is asking for permission to construct a system of underground electric railways similar to those of Paris. It is stated that French bankers are ready to invest $100,000,000 in the enterprise.

The Western Maryland Ry. Extension from Cumberland, Md., to Connellsville, Penn., described in Engineering News, Jan. 26, 1911, p. 104, was opened on Aug. 1. This extension gives a new route from the lake ports to the coast, via the Pittsburgh & Lake Erie R.R., which runs from Connellsville through Pittsburgh to Youngstown, Ohio, connecting there with all the lake ports of the New York Central Line. The new extension is 87 miles long, of which about 22 miles just west of Cumberland will be double tracked.

Bids for Dredging and improving the channel of the Neponset River in Boston, Dedham, and other towns are to be received by the Massachusetts State Board of Health on Aug. 26, 1912. The work was described in our issue of June 27, 1912. X. H. Goodnough is engineer and Mark W. Richardson is secretary of the Board.

Electric Traction will supplant steam on the Boston-Providence section of the New York, New Haven & Hartford R.R. This is the third section to be so operated and it will form part of a New York-Boston electric trunk line; the New York terminal zone (extending to Stamford, Conn.) is already under operation and an extension of the single-phase equipment to New Haven is under way. The work involves four tracking, grade reduction, and grade-crossing elimination. There will be a power house at Providence. The cost is estimated at about $7,000,000. Only a small portion of the Boston South Station and yard will be equipped at present.

The Electric-traction Power supply for the Third Avenue Ry. Co., New York City, will be in the hands of the New York Edison Co., after October, 1912. The Kingsbridge station of the railway company will be leased and operated by the central station company in connection with its Waterside generating plants. The Kingsbridge Station is a reciprocating-engine type while the Waterside Station has steam turbines. Both, however, are equipped with 6600-volt, three-phase, 25-cycle generators. The two generating systems will be merged and operated to secure the highest load-factor possible on the combined system. It is expected that there will be a saving also in the cost of future increases in capacity for both companies.

The Chicago Electrolysis Ordinance passed by the City Council, on July 15, is practically identical with the draft of the ordinance published in our issue of June 6. A slight change as to the difference of potential is that between any two points on the return, this must not exceed 12 volts; within a radius of one mile from the City Hall it must not exceed 1 volt between points 1000 ft. apart, and beyond that radius it must not exceed 1 volt between points 700 ft. apart. In the requirement as to return-current amperage on cable sheaths the mention of the amount of tin in the sheaths is omitted and the clause reads "for standard lead or lead-alloy sheaths of cables." The period allowed for compliance with the provisions of the ordinance is increased from six to nine months. Otherwise the ordinance now passed is identical with that prepared originally by W. Palmer, City Electrician.

Smoke Prevention—As noted previously in these columns, the Department of Industrial Research of the University of Pittsburgh has undertaken an investigation of the smoke nuisance in that city. The work is being carried on by 25 specialists and is considering all effects. On account of the large interest which has been manifested by a large number of officials in various American cities, the department has announced that the members of its staff are prepared to lecture on the following phases of the problem: (1) The Smoke Nuisance (a general presentation of the main phases); (2) Smoke and Public Health; (3) Smoke and Cost of Living; (4) Smoke and Plant Life; (5) Methods and Means of Smoke Abatement; (6) The Effect of Smoke on Buildings and Building Materials; (7) The Psychology of Smoke; (8) Smoke Nuisance and the Housekeeper.

The Smoke Investigation being conducted by the Chicago Association of Commerce, through its committee of investigation on smoke abatement and electrification of railway terminals, includes an inquiry as to the damage to property caused by smoke. A circular letter on this point has been issued recently under the direction of Horace G. Burt, Chief Engineer of the committee, which covers three main inquiries, as follows:

1. Is it practicable to determine, with a considerable degree of accuracy, the amount of loss and damage per annum to your building and its contents (separately) caused by smoke and such other pollutions of the atmosphere as dust, dirt, fumes, etc.?

2. Is it practicable also to separate the amount of loss and damage caused by smoke from that caused by other pollutions of the atmosphere?

3. What method would you suggest for determining such loss in each of the following cases: A, exterior of large office or business buildings; B, interior of these buildings (exclusive of furnishing); C, interior furnishing; D, merchandise, products, or such articles as are handled in these buildings?

The Typhoid Fever Epidemic at Ottawa, Ont., noted in our issue of last week, is gaining headway at an alarming rate. From the 60 cases reported a week ago the number has grown to 510 cases with seven deaths. Two emergency hospitals have been established and are already caring for 80 patients. In one day of 24 hours (July 30-31) no less than 90 new cases were reported. The outbreak is attributed to the pollution of the city water supply. The cases are distributed throughout the city and are for the most part mild in character. Unless checked soon the epidemic bids fair to become even worse than that of last year, when there were something like 1600 cases reported. Dr. W. T. Sheriff, City Medical Health Officer of Ottawa, is advising the use of typhoid vaccine to prevent frther spread of the epidemic.

Wireless Telegraph service is reported to have been opened commercially between San Francisco and Honolulu, T. H., Sunday, July 28, by the Federal Telegraph Co., using the Poulsen system. It is also reported that the company hopes to extend this service across the Pacific, the Honolulu station then being an intermediate relay.

Personals

Mr. W. E. Bohl has been appointed Acting Roadmaster of the Atchison, Topeka & Santa Fé Ry. at Dodge City, Kan., succeeding Mr. Edward Marshall.

Mr. Earl M. Seitz has resigned as Treasurer of the Lane Paving Co., Atlantic City, N. J., to become Manager of the Garden State Construction Co., Camden, N. J.

Dr. Albert Hale, of the Pan-American Union, has been chosen to represent the United States at the formal opening of the Madeira & Mamoré Ry., in Brazil, on Sept. 7.

Mr. H. B. Wright, M. Am. Inst. M. E., formerly Chief Engineer of the Pocahontas Consolidated Collieries Co., is now engaged in special work for the company at Pocahontas, Va.

Mr. F. W. Morse has resigned as Vice-President and General Manager of the Chicago & Alton R.R., and his former duties will be assumed by the new President, Mr. B. A. Worthington.

Mr. James T. Whittlesey, Assoc. Am. Inst. E. E., Chief Engineer of the Public Service Electric Co., Newark, N. J., has resigned to engage in consulting practice in San Francisco, Calif.

Mr. C. S. Lake, Superintendent of the New York, New Haven & Hartford R.R. at Waterbury, Conn., has been appointed General Superintendent of the Minneapolis & St. Louis R.R., at Minneapolis, Minn.

Mr. C. D. Sargent, M. Am. Soc. C. E., Resident Engineer of the St. Lawrence Canals, Cornwall, Ont., has been promoted to be Superintending Engineer, succeeding Mr. W. A. Stewart, Superintendent, resigned.

Mr. H. F. Wardwell, formerly Assistant Manager of the Central Locomotive & Car Works, Chicago, Ill., has opened an office in the Railway Exchange Bldg., Chicago, to engage in a railway equipment business.

Mr. A. R. Brown, Special Agent in charge of the rescue station work of the United States Bureau of Mines, has resigned and is now Assistant Superintendent of the second division of mines of the Tennessee Coal, Iron & R.R. Co.

Mr. F. D. Ritter, Assistant Engineer of Maintenance-of-Way of the National Rys. of Mexico, has been given jurisdiction over the Great Northern division, with headquarters at Mexico City, succeeding to a part of the duties of the late D. D. Colvin, Assoc. M. Am. Soc. C. E.

Mr. Charles Hansel, M. Am. Soc. C. E., a consulting engineer of New York City, who has been in charge of the work of the re-valuation of the railways and canals of New Jersey, has been selected by the State of Michigan to make valuations of certain railway properties in that state.

Mr. Horace Carpenter, for the past five years Mechanical Engineer for the Board of Water Supply of the City of New York, in charge of the design and construction of power plants and water controlling apparatus, has resigned to become General Manager of the Coffin Valve Co., of Boston, Mass.

Mr. R. R. Potter, for the past four years Assistant Editor of Engineering News, has accepted a position as Assistant Superintendent of the Blood Bros. Machine Co., manufacturers of automobile parts, Kalmazoo, Mich. Mr. Potter is a graduate in mechanical engineering

of the University of Michigan, class of 1907.

Mr. J. V. Kennedy has resigned his position as Superintendent of Terminals of the Cleveland, Cincinnati, Chicago & St. Louis R.R., at Cincinnati, Ohio, to become General Superintendent of the Cincinnati Northern R.R. at Van Wert, Ohio. Mr. Kennedy is succeeded at Cincinnati by Mr. B. C. Byers, formerly Trainmaster at Kankakee, Ill.

Dr. George H. Ashley, M. Am. Inst. M. E., for several years a geologist of the United States Geological Survey, and for two years (1910 and 1911) State Geologist of Tennessee, has been appointed Administrative Geologist of the United States Geological Survey, a newly created office, which is virtually equivalent to that of Vice-Director.

Mr. Ramon Fabela, Division Engineer of the National Rys. of Mexico at Puebla, Mex., has been promoted to be Assistant Engineer of Maintenance-of-Way of the Great Southern division, including the Pan-American R.R. and the Vera Cruz & Isthmus R.R., with headquarters at Colonia Station, Mexico City, succeeding to a part of the duties of the late D. D. Colvin, Assoc. M. Am. Soc. C. E.

Mr. Mortimer M. Cooke, Assoc. M. Am. Soc. C. E., Chief Engineer of the Wichita Falls & Northwestern and the Wichita Falls & Southern Rys. (Wichita Falls Route), at Wichita Falls, Tex., has resigned, effective Aug. 15, to become Assistant Engineer of the California Railroad Commission at San Francisco, Calif., under Mr. R. A. Thompson, M. Am. Soc. C. E., whom Mr. Cooke succeeded as Chief Engineer of the Wichita Falls Route in October, 1911.

Dr. Robert H. Fernald, M. Am. Soc. M. E., Professor of mechanical engineering at the Case School of Applied Science, Cleveland, Ohio, has received the appointment of Professor of mechanical engineering at the University of Pennsylvania, succeeding the late Prof. Spangler. Dr. Fernald is also Consulting Engineer of the United States Bureau of Mines and is widely known for his work on gas engine investigations and the application and development of producer-gas for power purposes.

Mr. B. R. Rickards, formerly Chief of Laboratories for the Ohio State Board of Health, at Columbus, Ohio, and for the past year Associate Professor of municipal and sanitary dairying at the Agricultural College of the University of Illinois, has accepted the position of Assistant Director and Bacteriologist in charge of the new biological department of Ely Lilly & Co., Indianapolis, Ind. This company is to establish a large plant for the manufacture of antitoxins, vaccines, etc., for medical and hygienic purposes.

Mr. F. F. Longley, Assoc. M. Am. Soc. C. E., Resident Engineer of the Toronto, Ont., water filtration plant, has resigned, effective Sept. 30, to become a member of the firm of Hazen & Whipple, consulting engineers, New York City. Mr. Longley had supervision of the construction of the slow sand filtration plant at Toronto, which was described by him in Engineering News of Mar. 9, 1911, and since its completion has had charge of its operation. Before going to Toronto, Mr. Longley was Resident Engineer on the Washington, D. C., water purification works.

Obituary

Ralph P. Gillette, Manager of Mechanical Sales of the Minneapolis Steel & Machinery Co., Minneapolis, Minn., died July 12.

John Henry Schaeffer, Assistant Engineer, Topographical Bureau, Borough of the Bronx, New York City, was found dead in his home on Aug. 6. He had been in the engineering department of the city for many years.

Frank H. Schwartz, a civil engineer of Pittsburgh, Penn., died on July 31, aged 57 years. For many years he was with the city engineering department of Pittsburgh, and was at one time Superintendent of the Bureau of Construction. He had been a member of the Engineers' Society of Western Pennsylvania since 1881.

William Albert Brown, an early surveyor and engineer in Northwestern Ontario, died at his home in Toronto, Ont., Aug. 4, in his 68th year. Much of his engineering experience was spent in Western Ontario, when the region about Port Arthur was a wilderness, and that city consisted of a very small settlement.

Charles L. Ewing, for several years Superintendent of the Southern Ry. at Knoxville, Tenn., died at his home in Chicago, Ill., on Aug. 4. Mr. Ewing retired from railway work in 1903. He was born at Zanesville, Ohio, in 1855, and began railway work as a brakeman on the Wabash, St. Louis & Pacific Ry. in 1876. He served in various positions with the Chicago, Rock Island & Pacific Ry., and for four years, 1890 to 1894, was Superintendent of Illinois division at Chicago, Ill. The following ten years he served in various positions on the Southern Ry.

Eugene Lamb Richards, Professor Emeritus of mathematics at Yale University and well known to several generations of Yale graduates, died at the summer home of his daughter at Beach Haven, N. J., on Aug. 5. Prof. Richards was born in Brooklyn, N. Y., in 1838 and graduated from Yale University in 1860. He was Tutor in mathematics from 1868 to 1871, Assistant Professor until 1891 and Professor from 1891 to 1906, when he retired from active work. For ten years (1892-1902) he was Director of the Yale Gymnasium. He was the author of a book on trigonometry and one on navigation and astronomy.

Harold Hervey Fletcher, Assistant Engineer of the Boston & Albany R.R., at Boston, Mass., died at the home of his parents in Brookline, Mass., on July 25. Mr. Fletcher was born in Springfield, Mass., in 1881. He graduated from the Massachusetts Institute of Technology in 1902, and after two years spent in travel in Europe, he entered the engineering department of the Baltimore & Ohio R.R. From 1904 to 1907 he was with the New York, New Haven & Hartford R.R. on the reconstruction of the road between Danbury and Waterbury, Conn. He had been with the Boston & Albany R.R. since 1908.

William D. Washburn, who died at his home in Minneapolis, Minn., July 29, was chiefly famous as an ex-United States Senator and as a wealthy flour manufacturer, but he will be remembered by old-time engineers as Surveyor General of Minnesota, from 1861 to 1865, and as the promoter and for many years President of the Minneapolis & St. Louis R.R., and of the Minneapolis, St. Paul & Sault Ste. Marie R.R. The foundations of his great fortune were laid in the Minnesota lumber industry. In recent years his name has become a household word in connection with Washburn & Crosby and Pillsbury-Washburn Co.'s flour mills at Minneapolis.

Engineering Societies

COMING MEETINGS

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 26-30. Annual convention at Peoria, Ill. Secy., Clarence R. George, Houston, Tex.

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 27-30. Annual convention at Chicago, Ill. Secy., W. O. Thompson, N. Y. C. car shops, East Buffalo, N. Y.

INTERNATIONAL CONGRESS FOR TESTING MATERIALS.
Sept. 2-7. Sixth congress at New York City. Secy. of organizing committee, H. F. J. Porter, 29 West 39th St., New York.

MICHIGAN GAS ASSOCIATION.
Sept. 4-6. Annual convention at Toronto, Ont., and on board steamer "Rochester." Secy., Glenn R. Chamberlain, Grand Rapids Gas Light Co., Grand Rapids, Mich.

INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.
Sept. 4 at Washington.
Sept. 6-13 at New York City. Secy., Bernhard C. Hesse, 25 Broad St., New York.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 7-10. Annual meeting at New York City. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Penn.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 9-12. Annual meeting at Hot Springs, Va. Asst. Secy., Walter Neumuller, 55 Duane St., New York.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 10-13. Annual convention at Denver, Colo. Secy., A. P. Dane, B. & M. R.R., Reading, Mass.

COLORADO ELECTRIC LIGHT, POWER AND RAILWAY ASSOCIATION.
Sept. 12-14. Annual convention at Glenwood Springs, Colo. Secy., Thos. F. Kennedy, 900 15th St., Denver, Colo.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 16-19. Annual convention at Niagara Falls, Canada. Secy., P. S. Millar, 29 West 39th St., New York.

NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 18-20. Annual convention at Washington, D. C. Secy., Willard Kent, Narragansett Pier, R. I.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 18-20. Annual meeting at Washington, D. C. Secy., Selskar M. Gunn, 755 Boylston St., Boston, Mass.

INTERNATIONAL CONGRESS ON HYGIENE AND DEMOGRAPHY.
Sept. 23-28. Fifteenth congress at Washington, D. C. Secy., John S. Fulton, Senate Annex, Washington, D. C.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Sept. 24-26. Annual convention at Buffalo, N. Y. Secy., R. D. Moldenke, Watchung, N. J.

NATIONAL IRRIGATION CONGRESS.
Sept. 30-Oct. 3. Annual meeting at Salt Lake City, Utah. Secy., Arthur Hooker, Salt Lake City.

AMERICAN ASSOCIATION FOR HIGHWAY IMPROVEMENTS.
Sept. 30-Oct. 5. Annual convention at Atlantic City, N. J. Secy., G. E. Pennybacker, Jr., Colorado Bldg., Washington, D. C.